City of Tacoma
Environmental Services Department

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Office of Environmental Cleanup

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Kristine Koch
Office of Environmental Cleanup
1200 6th Avenue, Suite 900, M/S ECL-122
Seattle, WA 98101-3140

Subject: Thea Foss and Wheeler-Osgood Waterways Long Term Monitoring Plan Preliminary Findings Memorandum – Subtidal Cap Hydrographic Survey – Year 12 Monitoring

Dear Ms. Koch:

Enclosed for your review are two copies of the final Year 12 Monitoring – Subtidal Cap Hydrographic Survey Preliminary Findings Memorandum. This memorandum was originally submitted on May 29, 2018 as outlined in the Long Term Monitoring Plan (LTMP) for the site. Revisions to the document were made as discussed with you at our meeting on June 15, 2018.

If you have any questions regarding this final memorandum, please do not hesitate to contact me at 253-502-2113.

Sincerely,

Mary Henley, P.E.
Project Manager

Enclosures

cc: Justine Barton, EPA (w/o attachment – link sent separately)
Jessi Massingale, Floyd Snider (w/o attachment – link sent separately)
Jackie Wezsteon, PacifiCorp (w/o attachment – link sent separately)
Marv Coleman, WDOE (w/o attachment – link sent separately)
Peter Striplin, WDOE (w/o attachment – link sent separately)
Shandra O'Haleck, NOAA (w/o attachment – link sent separately)
Lindie Schmidt, DNR (w/o attachment – link sent separately)
Melissa Malott, CHB (w/o attachment – link sent separately)

File: OMMP 23.4.4 – Subtidal Cap Hydrographic Survey PFM

REVISED PRELIMINARY FINDINGS MEMORANDUM
SUBTIDAL CAP HYDROGRAPHIC SURVEY
YEAR 12 MONITORING

1.0 Introduction

This Preliminary Findings Memorandum (PFM), which was revised to address comments provided by the United States Environmental Protection Agency (USEPA) during a June 15, 2018 meeting, presents the findings from the Year 12 (2018) Subtidal Cap Hydrographic Survey performed in subtidal slope, grout mat, and channel sand cap areas of the Thea Foss and Wheeler-Osgood Waterways (the site). In addition, a hydrographic survey was also completed in the remedial action area for the Murray Morgan Bridge (MMB), which was capped in February 2015. The Year 12 hydrographic survey was performed in accordance with the Physical Cap Integrity Operations Manual included as Appendix A of the *Thea Foss and Wheeler-Osgood Waterways Long-Term Monitoring Plan* (LTMP; City of Tacoma, 2018) and in accordance with the latest edition of the United States Army Corps of Engineers (USACE) Engineering Manual 1110-2-1003.

In accordance with the LTMP, subtidal cap hydrographic surveys are required to be performed during LTMP monitoring event Years 12, 17, and 22 within the areas shown on Figure 1. Hydrographic surveys will be conducted during high tide in all subtidal cap areas of the site to evaluate potential changes (i.e., loss of material) in cap thickness over time that may impact the effectiveness of the cap. The objective for hydrographic surveys of subtidal capped areas is to gather sufficient data density to provide complete and comprehensive coverage to assess the integrity of the cap in terms of potential long-term changes in cap thickness within the subtidal slope cap and channel sand cap areas. All LTMP hydrographic surveys will be compared to a baseline post-construction multibeam hydrographic survey that was completed within the capped areas of the site in either Year 0 or in Year 2. In addition, all LTMP hydrographic surveys will be compared to the most recent previous hydrographic survey to identify any more recent changes in condition. Data from the baseline multibeam survey will serve as the basis to evaluate long-term elevation changes within the subtidal slope and channel cap areas.

The following sections summarize hydrographic survey requirements, the findings of the Year 12 hydrographic survey, and the results of the comparative analyses between the baseline and Year 12 surveys and the Year 10 and Year 12 surveys. Included with this memorandum are attachments that contain the hydrographic survey contractor's (David Evans Associates Inc. [DEA]) report describing survey equipment and procedures for the Year 12 (2018) survey (Attachment A), and survey transect lines for the baseline, Year 2, Year 10, and Year 12 surveys (Attachment B).

2.0 Summary of LTMP Hydrographic Survey Requirements

The LTMP specifies that multibeam hydrographic surveys of the subtidal slope and channel cap areas will be conducted to evaluate elevation changes (i.e., loss of material) over time that could impact the physical integrity of the cap. Subtidal cap hydrographic surveys will generally be performed in subtidal slope and channel cap areas up to approximate elevation 0 feet MLLW. In the event of limited access due to the presence of marine structures (piers, floats, wharves, etc.) subtidal cap hydrographic survey coverage will be completed to the maximum extent possible. The subtidal cap hydrographic surveys are to be performed to provide adequate coverage of the required survey area (refer to Figure 1) and according to the methods described in Appendix A of the LTMP, including specifications listed in the QAPP for Cap Integrity Monitoring Data for all multibeam hydrographic surveys will be collected in a manner to ensure comparability to previous surveys.

Hydrographic survey results are compared to previous monitoring surveys to evaluate apparent changes in the cap elevation over time and to identify any potential erosional areas. Hydrographic survey data will be evaluated to identify whether there are areas where a contiguous region of the cap exhibits greater than six inches of net erosion relative to previous surveys. A loss of 6 inches or more of cap thickness in a localized contiguous area over two monitoring events may trigger a response action, as described in Section 3.2.

2.1 SUBTIDAL HYDROGRAPHIC SURVEYS COMPLETED AS PART OF THE OMMP

The post-construction hydrographic surveys completed in 2003 and 2005/2006 are used as the baseline (Year 0) bathymetric conditions for the cap areas. Where only single beam survey data are available or where construction was occurring during baseline surveys that prevented survey close to the shoreline, the Year 2 multibeam survey conducted in 2008 is also used for "baseline" comparison, as described below. There are a total of 16 remedial areas (RAs) that have subtidal slope, grout mat, and/or channel sand caps. A summary of the completed remedial action, descriptions, and RAs is included in Table 1. An overview of the baseline bathymetric conditions for all 16 RAs is shown in Figure 2.

Subtidal hydrographic surveys were completed during Years 2, 4, 7, and 10 in accordance with the OMMP to verify cap integrity and performance to ensure containment of the underlying contaminated sediments. A summary of these surveys is included in Table 2. Overviews of bathymetric conditions for the RAs in Years 2, 4, 7, and 10 are shown on Figures 3, 4, 5, and 6, respectively.

2.2 YEAR 12 HYDROGRAPHIC SURVEY

The Year 12 multibeam hydrographic survey was conducted by DEA in accordance with the LTMP on March 28-29, 2018, with additional quality control checks performed before, during, and following completion of the survey. The objective of the Year 12 multibeam survey was to obtain elevation data for subtidal capped areas, defined as the capped areas within RA boundaries extending up the shoreline to a target elevation of 0 feet mean lower low water (MLLW). Intertidal slope caps placed along the shoreline at elevations above 0 feet MLLW are monitored by low tide slope cap inspections as described in the LTMP. An overview of the Year 12 bathymetric conditions for all 16 RAs and the MMB subtidal cap area is shown in Figure 7. The Year 12 multibeam survey is shown for each subtidal cap area in Figures 8 through 17.

The survey was conducted aboard DEA's 19-foot survey vessel River Hawk. Soundings were acquired with a Reson SeaBat 7101 multibeam bathymetric sonar, and accurate positioning was determined using a Trimble SPS-855 RTK-GNSS rover, located on the vessel with a base station positioned at control point 2011 located on the east side of the Thea Foss Waterway. The hydrographic survey contractor report summarizing the equipment and procedures used for the Year 12 hydrographic survey is provided in Attachment A.

Multibeam data were collected by running lines both parallel and perpendicular to the waterway for the length of the project. Similar to the previous hydrographic surveys completed in accordance with the OMMP, the vessel was generally able to survey close to the shoreline. Additionally, multiple passes were performed with the survey vessel to try to acquire additional data in some areas where access was obstructed by marine structures, such as docks or boats. The following sections summarize the findings of the Year 12 hydrographic survey, and present the comparison of the baseline and Year 10 surveys to the Year 12 survey.

3.0 Year 12 Hydrographic Survey Results

As described above, the Year 12 hydrographic survey was conducted in March 2018. An overview of the Year 12 bathymetric conditions for all subtidal cap areas is shown in Figure 7; subtidal cap areas are shown in more detail in Figures 8 through 17.

In general, the Year 12 survey was comprehensive, with similar to better coverage than the Year 10 survey with only a few small scattered areas where complete survey data could not be collected. Of note, there was a large boat moored in front of the former Martinac Shipyard facility in RA14 during the survey (similar to during Year 7), which limited coverage in that RA. The areas where the extent of the Year 12 survey coverage was not complete are discussed below with the results for each RA.

3.1 COMPARABILITY OF THE YEAR 12 SURVEY TO PREVIOUS SURVEYS

The systems and procedures used for the baseline, and Years 2, 4, 7, 10, and 12 multibeam hydrographic surveys resulted in very good repeatability and survey comparability for the 16 RAs. The comparability for the MMB RA is discussed separately in Section 3.3.1. The following systems and procedures are used to evaluate comparability.

- **Equipment**: Nearly identical equipment was used in all six surveys; an improved sonar that provides better imaging was used in Years 10 and 12. Only the control points varied between the six surveys. The control points that were used for the Year 2, Year 4, Year 7, Year 10, and Year 12 surveys were established during remedial action construction. The control points that were used for the baseline survey were destroyed by construction activity.

- **Survey Coverage and Line Orientation**: During the baseline survey, obstructions, generally resulting from construction activities, prevented the vessel from surveying close to the shoreline. However, the subsequent surveys provided nearly complete coverage of subtidal capped areas. In general, the trackline orientation of the surveys was controlled by the shape of the waterway and the locations of various marine structures. Therefore, similar transect lines for the surveys were produced. It should be noted, however, that the need for duplicating survey transects is not as significant with multibeam surveys as it is with single beam surveys. The transect lines generated during the baseline, Year 2, Year 10, and Year 12 surveys are presented in Attachment B.

- **Quality Control and Checks**: Similar quality control procedures were used in all six surveys, which include the use of GPS control points, sound velocity casts, lead line depth measurements, and comparisons of RTK tide data to observed NOAA tides, among others. These quality control procedures are also discussed in the survey equipment and procedures memorandum for Year 12 multibeam survey (Attachment A). Memoranda for previous surveys were included in prior PFMs.

- **Feature Matching**: Data from a distinct feature in the central portion of the channel were used to further provide quality assurance of the multibeam surveys. The hill shade survey of the remnant bridge footing showed good repeatability between all six surveys.

As consistent equipment, procedures, and quality control were performed for the baseline and Years 2, 4, 7, 10, and 12 multibeam hydrographic surveys, the surveys are comparable. As the survey coverage was comprehensive and nearly complete, the Year 12 bathymetric data will provide an excellent surface for future LTMP survey comparisons.

Attachment A-1 of Appendix A of the LTMP, which is the QAPP for Cap Integrity Monitoring Data, specifies that the vertical datum for subtidal hydrographic surveys will be National Geodedic Vertical Datum of 1929 (NGVD 29). To be consistent and comparable with previous multibeam hydrographic surveys, the hydrographic surveys and bathymetric contours are presented relative to a project specific datum, referred to throughout this document as the USACE Port of Tacoma MLLW vertical datum (USACE POT MLLW, or MLLW), for the tidal epoch where National Geodedic Survey (NGS) Benchmark Tidal 22 = 20.0 feet USACE POT MLLW, converted from the NGVD 29 and consistent with the datum used for remedial construction.

3.2 COMPARISON OF THE YEAR 12 SURVEY TO BASELINE (OR YEAR 2) AND YEAR 10 SURVEY RESULTS

The following sections present the comparison of baseline or Year 2, and Year 10 survey results to the results of the Year 12 hydrographic survey performed in subtidal cap areas. In RAs 5, 6, 7A, 8, 9, 14, 16, 17, 18, 19A, 19B, 20, 21 and 22, multibeam surveys were performed during baseline, Year 10, and Year 12. In RAs 1 and 3, single beam surveys were performed during baseline while multibeam surveys were performed during Year 10 and Year 12. Therefore, for RAs 1 and 3, Year 12 is compared to the Year 2 multibeam hydrographic survey instead of the single beam baseline survey. The MMB RA survey results and comparison is provided in Section 3.3. Refer to Figure 1 for the subtidal hydrographic survey areas.

The comparison of the baseline multibeam bathymetric surface to the Year 12 multibeam bathymetric surface is presented in Figure 18. The bathymetric surfaces of RAs 1 and 3 were not included in the comparison provided in Figure 18 as single beam baseline surveys were performed in these RAs. A comparison of the bathymetric surfaces performed using multibeam surveys for Year 2 to Year 12 is included as Figure 19, for "baseline" comparison of RAs 1 and 3 since the surveys were performed in a similar manner. This comparison is also used for RAs 8, 19A, 19B, and 20 where obstructions from construction activities during the baseline multibeam surveys conducted in 2005 and 2006 prevented the survey vessel from obtaining complete coverage. The Year 10 multibeam bathymetric surface is compared to the Year 12 multibeam bathymetric surface in Figure 20. This figure does include a comparison of the Year 10 and Year 12 multibeam bathymetric surface for RAs 1 and 3 since they were performed in a similar manner.

The gray areas of the waterways in Figures 19 through 21 indicate areas where the change in elevations between the Year 12 survey and the baseline (or Year 2) survey and the Year 10 survey are within +/- six inches and within the allowable accuracy of the survey equipment (+/- six inches). Elevations highlighted in shades of green indicate areas that are shallower (i.e., higher elevations) in Year 12 relative to the baseline elevations surveyed in 2005/2006, the Year 2 elevations surveyed in 2008, or the Year 10 elevations surveyed in 2016. Elevations highlighted in shades of blue indicate areas that are deeper (i.e., lower elevations) in Year 12 than in 2005/2006 or 2016.

In shoreline slope areas that were inaccessible or blocked by large vessels, floats or obstructions, the baseline multibeam survey had to use wider sonar angles along the slopes and to reach under such obstructions, which can result in less accurate readings. In these shoreline slope areas where the baseline survey coverage was limited, there appears to be greater variance between the baseline and the Year 10 and Year 12 cap surface elevations, likely as a result of the wider sonar angles rather than actual changes in elevation. When these areas are compared to Year 2 where these wider sonar angles were not needed, there is significantly less variance (refer to Figure 19).

As single beam surveys provide a narrow transect of data in comparison to the broad coverage provided by multibeam surveys, the comparison of the baseline survey to the

Year 10 and Year 12 surveys for RAs 1 and 3 is performed by comparison to the Year 2 (2008) multibeam survey (Figure 19) and using cross sections. Four cross sections were prepared at regular intervals within these RAs to represent typical conditions in RAs 1 and 3; cross section locations are shown in Figures 21 and 23. Cross sections were also used for comparison in shoreline slope cap areas where the comparison of baseline to Year 10 and Year 12 hydrographic surveys were difficult due to limited coverage of the baseline multibeam survey. Cross sections comprised of Manson single beam surveys, Year 10 multibeam and Year 12 multibeam survey data were prepared and are discussed in specific RA sections below.

As specified in the LTMP and described above, one of the performance criteria for the long-term compliance of the sediment cap areas is to maintain a minimum cap thickness of three feet as per the ROD. If the results of the subtidal hydrographic surveys show that there is loss of 6 inches or more of cap thickness in a contiguous area over two monitoring events, then cap chemical performance monitoring shall be conducted via coring as a response action, where possible. Other potential response actions in the cap areas include, but are not limited to, conducting additional surveys or supplemental field inspections, completing sediment cap or grout map repairs, or implementing administrative controls to minimize cap disturbance.

If monitoring demonstrates a loss in cap thickness over the course of two monitoring events and that the loss of cap material may be impacting the ability of the cap to prevent contaminant migration, a modification to the remedy, which may involve the above-mentioned response actions, will be implemented as soon as reasonably possible. Implementation of potential response actions will also be informed by the evaluation of other LTMP data collected in or surrounding the impacted cap area, such as waterway source monitoring data.

The results of survey comparisons are presented below for each RA that includes subtidal capped areas. The following sections describe the capped area within each RA, the composition of subtidal cap, extent of coverage of the baseline, Year 2, Year 10, and Year 12 hydrographic surveys, and results of the survey comparisons.

3.2.1 Remedial Area 1

The subtidal cap area in RA 1 is located on the western side of the Thea Foss Waterway adjacent to Thea's Park between approximate Station 2+00 and Station 7+00, at the mouth of the channel. The subtidal cap area in RA 1 consists of slope cap comprised of riprap, slope cap filter material, and habitat mix.

The Year 12 multibeam survey provided complete coverage of the capped area within RA 1 (Figure 8). The baseline (post-construction) survey in RA 1 was conducted using single beam surveys. Therefore, the Year 12 cap surveys are evaluated by comparing elevations to Year 2 (Figure 19) and by comparing elevations along prepared cross sections located along single beam survey transects. Both the Year 10 and Year 12 surveys were conducted using multibeam. Figure 21 shows the cross section or transect locations throughout the capped area of RA 1, and Figure 22 presents the comparison between the baseline, Year 10, and Year 12 elevations at each of four cross section locations: A-A', B-B', C-C', and D-D'. The surface elevations for each of the three surveys, at 10-foot intervals along the cross sections, as well as the differences between the baseline and the Year 12 elevations and between the Year 10 and Year 12 elevations are shown on the bottom of each cross section.

The channel capped areas of RA 1 in Year 2, Year 10, and Year 12 surveys (i.e., below approximate elevations -25 to -30 feet MLLW) show consistent elevations, do not indicate any compaction or erosion, and are generally within six inches of each other and within the allowable accuracy of the survey equipment. Along the shoreline slope capped areas, the Year 12 survey shows elevations that are lower than the baseline elevations in the cross sections discussed above, but when compared to the Year 2 survey, these same areas show an increase in cap thickness. Elevations of the Year 12 survey are generally within 0 to 0.4 feet of the Year 10 survey elevations as shown by the cross sections (Figure 22), and the comparison figure (Figure 20). Consistent with the Year 10 surveyed elevations, the Year 12 elevations along the slope and channel do not indicate sloughing, since at the toe of the slope the elevations are relatively consistent.

No response actions are warranted based on the results of comparison of Year 2 and Year 12 hydrographic surveys in RA 1. An evaluation of the results indicates that there are no indications of sloughing or erosional forces; however as observed and described in previous monitoring reports, this area is known to experience wave action and associated weathering that can relocate slope cap materials.

3.2.2 Remedial Area 3

The subtidal cap area in RA 3 is located on the eastern side of the Thea Foss Waterway adjacent to Commencement Bay Marine (formerly Totem Marine) between approximate Station 27+00 and Station 31+00. The subtidal cap area in RA 3 consists of grout mat or a slope cap composed of riprap, slope cap filter material, and habitat mix. Since the Year 4 survey took place, the landowner has done significant improvements to the property. In particular, the floats in the marina have been reconfigured with some pile removal and reinstallation performed as part of the project.

The Year 12 multibeam survey provided complete coverage of the capped area within RA 3 (Figure 9). Similar to RA 1, the baseline survey in RA 3 was conducted using single beam surveys. Therefore, comparison of the Year 12 survey to baseline was conducted by comparing elevations to Year 2 (Figure 19) and along prepared cross sections. Figure 23 shows the cross section locations throughout the capped area of RA 3, and Figure 24 presents the comparison between the baseline, Year 2,Year 10 and Year 12 elevations at each of four cross section locations: E-E', F-F', G-G', and H-H'. The surface elevations for each of the three surveys at 10-foot intervals along the cross sections, as well as the difference between the baseline and the Year 12 elevations, and between the Year 10 and Year 12 elevations are shown on the bottom of each cross section.

In the harbor areas of RA 3 (i.e., below approximate elevations of -25 feet MLLW), the baseline, Year 2, Year 10, and Year 12 surveys show consistent elevations, do not indicate any compaction or erosion, and are generally within six inches of each other. Along the shoreline slope capped areas the Year 12 survey when compared to Year 10, shows a slight decrease in elevation up to 0.2 feet (2.4 inches). There is a fairly continuous area approximately 50 feet wide, of greater decrease in elevation from Year 10 to Year 12 that is located outside of the hydrographic survey target extent and above 0 feet MLLW (Figure 20). This greater difference could also be attributed to artifacts and the limitations of the survey beam extending that far up the shoreline. RA 3 shoreline conditions above 0 feet MLLW will be inspected as part of the Year 12 low tide slope cap inspections in accordance with the LTMP and will be used to supplement the hydrographic survey analysis. The Year 12 and Year 10 cross section elevations are otherwise consistent with few elevation differences. Comparison of the Year 10 and Year 12 multibeam surveys, shown in Figure 20, indicates scattered, small scale occurrences of both increased and decreased elevation changes between the two surveys, but generally the Year 10 and Year 12 surveys show elevations throughout most of the area within the range of 0 to 6 inches relative to one another.

The largest decrease in elevation in Year 12 compared to Year 2 was located in cross section F-F' at station 0+70, with a decrease of 1.3 feet. Other lesser decreases in elevation from Year 2 to Year 12 were observed in cross-sections G-G' (Stations 0+60 and 0+70) and H-H' (Station 0+60), but when Year 12 is compared to Year 10, there has been little to no change. Similar to RA 1, the Year 12 elevations along the slope and channel do not indicate sloughing, since at the toe of the slope the elevations are relatively consistent and within the allowable accuracy of the survey equipment.

The Year 12 survey indicates that some settlement/subsidence, or redistribution of material has occurred in localized areas along the slope between Year 10 and Year 12, but does not indicate that sloughing or scour is occurring such that deposition is occurring down slope of this area. The Year 10 and Year 12 survey elevations are both lower and higher at various locations along the slope when compared to the Year 2 survey, but generally within 6 inches when compared to each other. In this area, low tide slope cap inspections are also performed in accordance with the LTMP and will be used to supplement the hydrographic survey analysis to further evaluate the conditions in this area.

No response actions are warranted based on the results of comparison of Year 2, Year 10 and Year 12 hydrographic surveys in RA 3. An evaluation of the results indicates that there are no significant indications of sloughing or erosional forces.

3.2.3 Remedial Area 5

The subtidal cap area in RA 5 is located on the eastern side of the Thea Foss Waterway in the area adjacent to the Petrich Marine Dock between Station 37+10 on the north and

Station 39+75 on the south. A small houseboat was located within RA5, but did not impact coverage of the survey. The subtidal cap area in RA 5 consists of slope cap composed of riprap and slope cap filter material.

The Year 12 survey provided complete coverage of the capped area within RA 5 (see Figure 10). The extent of the baseline multibeam survey along the shoreline slope capped area within RA 5 was limited to approximate elevations of -10 to -12 feet MLLW, rather than 0 feet MLLW.

In general, the Year 12 capped surface elevation is within six inches of the baseline surface elevation and within the allowable accuracy of the survey equipment. There are small, localized, non-contiguous points across RA 5 where increases in the cap surface elevation is generally greater than six inches but less than one foot (Figure 18). The Year 12 surface elevation is also generally within six inches of the Year 10 surface elevation and within the allowable accuracy of the survey equipment (see Figure 20). No response actions are warranted in RA 5.

3.2.4 Remedial Area 6

The subtidal cap area in RA 6 is located between approximate Station 48+50 and Station 50+50 adjacent to Outfall 230. The subtidal cap area in RA 6 consists of a channel sand cap. Slope caps constructed in RA 8 extend into RA 6 but are not considered a component of RA 6 for the purpose of subtidal cap integrity monitoring. The Year 12 and Year 10 surveys provided complete coverage of the capped area within RA 6. The baseline multibeam survey also provided complete coverage of the capped area within RA 6. Refer to Figure 11 for the Year 12 survey results.

In general, the Year 12 capped surface is within six inches of both the baseline post-construction capped surface and the Year 10 surface, which is within the allowable accuracy of the survey equipment (Figures 18 and 20), with exception of sediment accumulation downslope of Outfall 230 (described further in Section 3.2.6 for RA 8). There is a contiguous area with sediment accumulation (increase in elevation) at Station 50+00 between Year 12 and baseline (up to 18 inches). When Year 12 is compared to Year 10, this accumulation area is significantly smaller and generally within 6 inches (with a small area greater than 6 inches but less than a foot). No response actions are warranted for RA 6.

3.2.5 Remedial Area 7A

RA 7A is located in the Foss Harbor Marina (formerly Foss Waterway Marina) harbor area on the west side of the Thea Foss Waterway, within RA 7. The subtidal cap area in RA 7A consists of a channel sand cap. Slope caps constructed in RA 8 extend into RA 7A, but are not considered a component of RA 7A for the purpose of subtidal cap integrity monitoring.

The Year 12 and Year 10 surveys provided complete coverage of the capped area within RA 7A. Refer to Figure 12 for the Year 12 survey results. The baseline multibeam survey provided nearly complete coverage of the capped area within RA 7A, excluding a small area, approximately 14 square feet (sf) feet in size, located adjacent to the shoreward-most marina float.

In general, the Year 12 capped surface is within six inches the Year 10 surface, which is within the allowable accuracy of the survey equipment, but there are some increases in elevation indicating sediment accumulation up to a foot when compared to baseline. There are small, localized, non-contiguous points where the change (increase and decrease) in the cap surface elevation is slightly greater than six inches but less than one foot (Figures 18 and 20). As these points are localized and do not represent a contiguous region of elevation change, no response actions are warranted in RA 7A.

3.2.6 Remedial Area 8

The subtidal cap area in RA 8 is located along the western shoreline from Station 52+34 on its southern boundary to Station 34+91 on the north. The subtidal cap area in RA 8 consists of thick slope cap comprised of slope cap filter material, riprap, quarry spalls, and habitat mix. The Year 12 and Year 10 surveys provided nearly complete coverage of the capped area within RA 8. See Figure 12 for the Year 12 survey results.

There is one very small area adjacent to elevation 0 feet MLLW, at the north end of the RA boundary, where complete coverage could not be obtained due to the presence of boats within the marina (Figure 12), consistent with the Year 10 survey.

There are two shoreline areas where the extent of the baseline multibeam survey was limited and did not extend to elevation 0 feet MLLW. These areas are located shoreward of the sea plane float near Outfall 230, and shoreward of the Foss Harbor Marina floats (Figure 2). In these areas, post-construction single beam surveys performed by Manson were reviewed and, where available, shoreline slope survey transects were used for comparison between the baseline, Year 10 and Year 12 surveys to evaluate cap surface elevations. These cross section comparison locations are identified on Figure 20.

Three baseline single beam cross section profiles were available for the area around the sea plane float and Outfall 230. Final post-construction baseline transects were not available in the Foss Harbor Marina area where there is limited baseline multibeam survey coverage. These final baseline cross sections were not available due to the presence of marina floats and structures that prevented survey coverage. However, in this area low tide slope cap inspections are also performed under the LTMP to supplement the hydrographic survey analysis in areas where complete hydrographic coverage is limited. In shoreline slope areas that were inaccessible or blocked by large vessels, floats or obstructions, the baseline multibeam survey had to use wider sonar angles along the slopes and to reach under such obstructions, which can result in less accurate readings. In these shoreline slope areas where the baseline survey coverage is limited there appears to be greater variance (showing both increase and decrease) between the baseline and Year 12 cap surface elevations (Figure 18); therefore, Year 12 elevations were also compared to Year 2 elevations (Figure 19), which provided more complete coverage than baseline. With the exception of the area in front of Outfall

230, as described below, comparison of the Year 10 multibeam survey and the Year 12 multibeam survey shows limited areas of variation (both increase and decrease) and limited areas of increase in cap surface elevation of between 6 inches and less than one foot (Figure 25), as described in greater detail below.

Over the predominant portion of RA 8, the Year 12 capped surface elevation is within six inches of the baseline surface elevation and within the allowable accuracy of the survey equipment. There are localized, non-contiguous points within RA 8 where the increase or decrease in the cap surface elevation is slightly greater than six inches but less than one foot (Figure 19).

Along the shoreline, under the shoreward marina float located at approximate Station 41+00, there is an area where the comparison of the Year 12 survey to baseline identified a decrease in the cap surface elevation of greater than six inches, with some points indicating a decrease in elevation of greater than one foot (Figure 18). This decrease is not evident in Year 2 (Figure 19), but an increase in material is observed. Conditions observed in the Year 12 survey are consistent with the observations from the Year 10 survey (Figure 20), and do not indicate that settlement or subsidence has occurred in this location.

Several areas have cap surface elevations in the Year 10 and Year 12 surveys that are over one foot higher than baseline surface elevations. The areas with higher surface elevations are in locations where cap maintenance activities were previously performed within the Foss Harbor Marina and adjacent to Outfall 230. Additional slope cap materials including riprap, quarry spalls, and slope cap filter material were placed up to three feet deep resulting in higher slope elevations in these maintenance areas in RA 8. Previous chemical performance monitoring does not indicate that there is a concern with the slope cap relative to chemical concentrations and compliance with the SQOs or cap physical integrity.

Comparison of the Year 10 and Year 12 surveys generally indicates material deposition of greater than one foot at Outfall 230 at approximate Station 50+00. The results of the Year 12 survey do not indicate that scour is evident at the mouth of Outfall 230, as it has during previous surveys. This area will also be evaluated during the upcoming low tide cap inspections.

There are three cross section comparisons at the sea plane float adjacent to Outfall 230 at Station 49+00, Station 49+50, and Station 50+75 (Figure 20). Figure 25 presents the comparison between the baseline, Year 2, Year 10 and Year 12 elevations at each of the three cross section locations: I-I', J-J', and K-K'. The surface elevation recorded during each survey at 10-foot intervals along the slope of the cross sections are shown on the bottom of each section. Low tide slope cap inspections will supplement the hydrographic survey analysis in the area adjacent to the sea plane float and surrounding Outfall 230 where baseline survey coverage was slightly limited from approximately -4 to 0 feet MLLW.

The comparisons of the Year 2 with the Year 10 and Year 12 multibeam surveys along this portion of the shoreline of RA 8 show that the majority of the Year 12 capped surface is within six inches of the baseline capped surface and within the allowable accuracy of the survey equipment. The greatest difference between Year 2 and Year 12 cap elevations was an increase in cap elevation of 0.6 feet, observed at Station 8+80 along cross section J-J' (Figure 25). In Year 10, the cap elevation was 0.7 feet higher relative to the Year 2 elevation. Other cross sections show relatively stable conditions, with less than 6-inches of change in cap elevation from baseline to Year 12.

The areas of increased down slope elevations may indicate that sloughing of the cap material has occurred to some extent. The areas of decreased elevation in RA 8 are localized and non-contiguous, therefore, no additional response actions are warranted in RA 8.

3.2.7 Remedial Area 9

The subtidal cap area in RA 9 is located in the mouth of the Wheeler-Osgood Waterway between Wheeler-Osgood Station 5+00 and Station 10+00. The subtidal cap area in RA 9 consists of a channel sand cap. The Year 12, Year 10, and baseline multibeam surveys all provided complete coverage of the capped area within RA 9. Refer to Figure 13 for the Year 12 survey results.

In general, the majority of the Year 12 capped surface elevation is within six inches of the baseline surface elevation and within the allowable accuracy of the survey equipment, with the exception of a few localized areas along the central portion of the RA (Figure 18). When comparing Year 12 to Year 10, there is an approximately 15 foot wide small scour area (decreased cap elevation) at approximate Station 8+20 visible along the central portion of the RA (Figure 20), with a decrease in elevation greater than a foot but less than eighteen inches. When comparing the Year 12 cap elevation to baseline, there is a larger footprint scour area visible from approximate Station 7+50 to 8+20 (Figure 18) where greater than six inches but generally less than one foot of elevation decrease, but minimal change is apparent between Year 10 and Year 12. There are several contiguous areas of cap increase (sediment accumulation) along the outer edges of the survey area when comparing Year 12 to baseline (Figure 18), which indicates potential sloughing or material redistribution rather than cap settlement.

Sediment sample results collected in 2010 and 2016 in previously identified scour/depression areas indicate that the cap is functioning as intended and continuing to provide containment of contaminated sediment. Additionally, waterway source monitoring sample station WS-4 is located in this area and a sediment sample will be collected from this station during Year 12 LTMP monitoring to further evaluate conditions in RA9. The area of scour identified in the central portion of the channel in Year 12 is very small and localized (smaller than previous scour area), therefore, response actions are not warranted for RA 9.

3.2.8 Remedial Area 14

The subtidal cap area in RA 14 is located on the eastern side of the Thea Foss Waterway in the area adjacent to the former J.M. Martinac Shipbuilding facility, which was no longer operational during both the Year 10 (2016) and Year 12 (2018) surveys. The subtidal cap area in RA 14 consists of slope cap composed of slope cap filter material, quarry spalls, and habitat mix.

The Year 12 survey did not provide complete coverage in a large continuous area, an approximate 150 foot long and up to 40 foot wide area in the east central capped area within RA 14 (Figure 14). The Year 10 survey provided significantly more coverage than in Year 12 because there was a large ship moored in front of the facility in 2018 that was not present in 2016. Photographs of the vessel are included in Attachment C for reference. However, the extent of the Year 12 multibeam survey in the southeastern (shoreward) portion of the capped area within RA 14 provided better coverage than in Year 10 and previous surveys, which were limited to approximate elevations -2 or -4 feet MLLW rather than 0 feet MLLW.

Comparison of the baseline and Year 12 surveys shows that in approximately one-third of the capped area within RA 14, the Year 12 elevation is higher than the baseline elevation by greater than 12 inches (Figure 18), consistent with Year 10. This was also previously observed in the comparison of the Year 2 and Year 4 surface elevations to the baseline surface elevation. Upon review of the dates of the baseline survey and final cap construction it was determined that the slope cap in RA 14 was completed on January 4, 2006, and the baseline survey was performed in RA 14 prior to cap completion on December 22, 2005. Therefore, the baseline survey did not include the final capped surface elevation.

In general, the Year 12 capped surface elevation is within six inches of the Year 10 surface elevation and within the allowable accuracy of the survey equipment (Figure 20). There are a few small, localized, non-contiguous points across RA 14 where the change (increase or decrease) in the cap surface elevation is greater than six inches but less than one foot. There is one fairly continuous area approximately 10 by 50 where there is an increase in elevation greater than six inches but less than a foot, this area is immediately north of the large boat that was moored and may be associated with deposition during mooring operations.

In the slope cap area of RA 14, low tide slope cap inspections are also performed in accordance with the LTMP and can be used to supplement the hydrographic survey analysis in areas where complete hydrographic coverage was limited. The localized areas showing surface decrease, slightly greater than six inches and less than a foot do not represent a contiguous region of elevation change, therefore, response actions are not warranted for RA 14.

3.2.9 Remedial Area 16

The two subtidal cap areas in RA 16 are located on the eastern side of the Thea Foss Waterway within Delin Docks Marina between Station 57+00 and Station 58+85, and Station 52+50 and Station 55+25. The subtidal cap areas in RA 16 consist of a channel sand cap. The Year 12 survey provided complete coverage of the capped area within RA 16. See Figure 15 for the survey results. In the northern capped area within RA 16, the extent of the baseline multibeam survey was limited under the shoreward floats and did not extend to the shoreward edge of the capped area as visible in the comparison of the baseline and Year 12 surveys (Figure 18).

In general, the Year 12 capped surface is within six inches of the baseline post-construction capped surface and within the allowable accuracy of the survey equipment. In both the northern and southern capped portions of RA 16, the areas beneath the marina floats contain several non-contiguous points where the increase in the cap surface elevation is slightly greater than six inches but less than one foot, and a few instances where increases in cap elevation are greater than one foot. These elevation increases are visible in the comparison of the Year 12 survey to baseline (Figure 18), but are not visible when compared to the Year 10 survey (Figure 20). These points may represent areas of less accurate survey data due to the location of the marine floats, and limited access to the area, or may be representative of deposition of sediment and shell debris beneath the marine float structures which is a common occurrence in similar environments. This occurrence of elevated surface is observed beneath marina floats in other RAs in the waterway as well. As these points are localized and do not represent a contiguous region of elevation change, no response actions are warranted in RA 16.

3.2.10 Remedial Area 17

The subtidal cap area in RA 17 is located in the central channel of the Thea Foss Waterway, adjacent to the capped areas within RA 16 and RA 19A. The subtidal cap area in RA 17 consists of a channel sand cap from Station 54+85 to Station 58+75. The Year 12, Year 10, and baseline multibeam surveys each provided complete coverage of the capped area within RA 17. Refer to Figure 15 for the Year 12 survey results.

In the majority of the capped area within RA 17, the Year 12 cap surface elevation is within six inches of the baseline surface elevation and within the allowable accuracy of the survey equipment. There is an area between approximate Station 56+00 and Station 57+00 where the decrease in the Year 12 cap surface elevation is greater than six inches but less than one foot relative to the baseline surface elevation (Figure 18). However this area of decrease has been previously observed since Year 2 (2008) in the comparisons of the surface elevation to the baseline surface elevation, and appears to be an area of settlement/subsidence or redistribution of cap material that occurred sometime between construction and Year 2. There is not an adjacent area of increased elevation which would indicate movement of material in the immediate area. A comparison of the Year 12 cap surface to the Year 10 cap surface shows that elevations have remained within six inches since 2016 and are within the allowable accuracy of the survey equipment (Figure 20).

The elevations between Year 10 and Year 12 are consistent, generally with differences of less than 6 inches indicating that additional cap settlement or subsidence has not occurred. This, along with the Year 12 to baseline surface comparison which exhibits a potential change in cap elevation that is less than one foot, indicates that no response actions are warranted in RA 17.

3.2.11 Remedial Area 18

The subtidal cap area in RA 18 is located in the central channel of the Thea Foss Waterway, adjacent to the capped area within RA 17 and RA 19A. The subtidal cap area in RA 18 consists of a channel sand cap. The Year 12, Year 10, and the baseline multibeam surveys each provided complete coverage of the capped area within RA 18. Refer to Figure 15 for the Year 12 survey results.

In general, the Year 12 capped surface elevation is generally within six inches of both the baseline surface elevation (Figure 18) and the Year 10 surface elevation (Figure 20), which is within the allowable accuracy of the survey equipment. In comparing the Year 12 surface elevation to the baseline surface elevation, there are several small, localized, non-contiguous points (less than 5 sf in size) where the change (increase or decrease) in the Year 12 cap surface elevation is slightly greater than six inches but less than one foot. As these points are localized, generally less than one foot, and do not represent a contiguous region of elevation change, no response actions are warranted in RA 18.

3.2.12 Remedial Area 19A

The subtidal cap area in RA 19A is located on the southwestern shoreline of the Thea Foss Waterway, adjacent to capped areas of RA 17, RA 18, RA 19B, and RA 21. The subtidal cap area in RA 19A consists of a combination of a grout mat, channel sand cap, and a slope cap composed of slope cap filter material, riprap, and habitat mix.

In RA 19A, a six-inch thick grout-filled Uniform Section Mat (USM) was placed on the bottom of the channel from approximately four feet into the channel across the channel line and up to an elevation of +3 feet MLLW between approximate Station 68+00 and Station 65+50. The USM was then overlain with a 12-inch layer of channel sand and the slopes covered with a slope cap consisting of filter material, riprap, and habitat mix. In RA 19A between approximate Station 65+50 and Station 62+25, a channel sand cap was placed in the harbor areas and a cap composed of slope cap filter material, riprap, and habitat mix was placed on the shoreline.

The Year 12 survey provided complete coverage of the capped areas within RA 19A; refer to Figures 15 and 16 for the survey results. There were small areas under marina floats and docked boats where complete survey coverage could not be obtained during Year 10, which were fairly consistent with previous surveys. The use of a smaller boat during Year 12 provided better accessibility to tight areas and full coverage. The baseline multibeam survey had limited coverage in the Dock Street Marina area extending from the shoreward-most floats to 0 feet MLLW along the western boundary of RA 19A (Figure 2). In these areas, where available, post-construction single beam surveys performed by Manson were reviewed and shoreline slope survey transects were used for comparison between the baseline, Year 10 and Year 12 surveys to evaluate cap surface elevations. The cross section comparison locations are identified on Figures 18 and 20.

In shoreline slope areas that were inaccessible or blocked by large vessels, floats or obstructions, the baseline multibeam survey had to use wider sonar angles along the slopes and to reach under such obstructions, which can result in less accurate readings. In the shoreline slope areas where the baseline survey coverage is limited there appears to be greater apparent variance between the baseline and Year 10 and Year 12 cap surface elevations. However, this variance is likely due in part to the wider sonar angles that were necessary to reach under obstructions during the baseline survey rather than actual changes in elevation of the cap surface. Therefore, Year 12 elevations were also compared to Year 2 elevations (Figure 19), which provided more complete coverage than baseline.

Two cross section comparisons were performed for the area adjacent to Dock Street Marina (Station 56+00 and Station 57+00) and one cross section comparison was performed for the area further south (Station 62+75). Figure 26 presents the comparison between the baseline, Year 2, Year 10 and Year 12 elevations at each of the three cross section locations: L-L', M-M', and N-N'. The surface elevations for each of the three surveys at 10-foot intervals along the cross sections, as well as the difference between the baseline and the Year 12 elevations and between the Year 10 and Year 12 elevations, are shown on the bottom of each cross section.

Over the majority of RA 19A, the Year 12 capped surface elevation was within six inches of the baseline and Year 10 surface elevations and within the allowable accuracy of the survey equipment. There are small, localized, non-contiguous points where the increase or decrease in the cap surface elevation is slightly greater than six inches but less than one foot (Figure 18). Decreases in the cap surface elevations of greater than six inches are present in RA 19A when compared to baseline, generally between the following approximate stations: Station 54+00 to Station 60+00; and Station 60+50 to Station 61+80. When compared to Year 2, these areas of decrease are not evident.

Along the shoreward portion of the capped area within RA 19A, adjacent to Dock Street Marina between Station 54+00 and Station 60+00, the baseline multibeam survey coverage was limited from approximately -10 to 0 feet MLLW. The comparison of the baseline (where available) and Year 12 multibeam surveys in this area showed that there is a decrease in cap elevation that is greater than six inches, and at some points the decrease is greater than one foot. When compared to Year 2, these areas show an increase in cap thickness. Comparison of the Year 12 and Year 10 surveys indicates changes in cap surface elevation from Year 10 to Year 12 occur in more limited, localized, non-contiguous areas that include both decreased and increased cap elevations. Increased cap elevations are mainly between Stations 58+00 and 60+00 and decreased cap elevations are mainly around stations 62+50 and 64+50. Additionally, the comparison of the Year 2 with the Year 12 multibeam survey show that the Year 12 cap surface elevations range from 0.8 foot higher to 0.6 foot lower than the baseline cap surface elevations (Figure 26). This is a similar range to the variation in elevation between the Year 10 and Year 2 surveys. There may have been some settlement or subsidence that occurred between baseline and Year 2, as an increase in the surface elevation is not present down slope from the area of decreased elevation, and elevation changes between Year 10 and Year 12 are more limited.

Along the shoreline, between approximate Station 60+50 and Station 61+80, there are non-contiguous points where the decrease in the cap surface elevation is greater than six inches but less than one foot, with a small area greater than a foot, between the baseline and Year 12 surveys (Figure 18). This area is not visible in the comparison of the Year 2 to Year 12 (Figure 19) or the Year 10 and Year 12 surveys with few scattered areas of cap elevation increase (Figure 20) indicating conditions in this area have remained consistent since completion of the Year 2 survey.

In the RA 19A subtidal cap area overlying the grout mat and under the marina floats (Station 62+00 to Station 63+00) the baseline survey coverage was limited from approximately -10 to 0 feet MLLW. The comparison of the baseline and Year 12 surveys indicate there are localized points where there are increases in the cap elevation that are greater than six inches. A comparison of a baseline single beam transect with the Year 12 multibeam survey was conducted at Station 62+75 (cross section N-N') and showed that the Year 12 capped surface is within six inches of the baseline post-construction capped surface and within the allowable accuracy of the survey equipment (Figure 26).

Consistent with the Year 10 survey, comparison of the Year 12 and baseline surveys indicates an area of increased cap elevation ranging from 6 inches to greater than 1 foot between approximate Station 64+80 to Station 68+50, which is not evident in the comparison to the Year 2 survey indicating conditions in this area have not changed substantially since completion of the Year 2 survey (Figure 19).

As stated above, over the predominant portion of RA 19A, the Year 12 capped surface is within six inches of the baseline post-construction capped surface and within the allowable accuracy of the survey equipment. Areas that appeared to show a decrease in cap elevation during baseline are not evident when compared to Year 2. There are small, localized, non-contiguous points where there are increases and decreases in the cap surface elevations that are slightly greater than six inches. Therefore, no response actions are warranted in the shoreline areas of RA 19A.

3.2.13 Remedial Area 19B

The subtidal cap area in RA 19B is located on the southwestern shoreline of the Thea Foss Waterway, adjacent to the sheetpile wall separating the City and Utilities remedial work areas (approximate Station 70+10) and RA 19A. The subtidal cap area in RA 19B consists of a combination of grout mat, channel sand cap, and a slope cap composed of slope cap filter material, riprap, and habitat mix. The grout mat as described above in RA 19A is also present in RA 19B, extending from Station 68+00 to Station 70+10. The Year 12 survey provided complete coverage of the capped areas within RA 19B, refer to Figure 16 for the survey results. Baseline survey data in RA 19B are limited along the shoreline from approximate Station 62+30 to Station 63+00 and from approximate Station 64+50 to Station 68+75. However, comparison of the Year 10 and Year 12 surveys was possible due to the increased data coverage by both multibeam surveys (Figure 20).

Over the majority of RA 19B, the Year 12 capped surface elevation is within six inches of the baseline surface elevation and within the allowable accuracy of the survey equipment (Figure 18). However, as mentioned above, and relatively consistent with the Year 10 survey, there are two areas in RA 19B with limited baseline survey coverage, and increases and decreases in the cap surface elevations of greater than six inches appear to be present. These areas are located at the following approximate stations; Station 64+50 to Station 68+75, and Station 68+80 to Station 70+10, and discussed below. Year 12 elevations for these areas were also compared to Year 2 elevations (Figure 19), which provided more complete coverage than baseline.

Along the shoreline, between approximate Station 64+50 and Station 68+75, there is an area where the increase in the cap surface elevation is greater than one foot as discussed in the section above for RA 19A (Figure 18). The RA 19A area continues into RA 19B at Station 68+00, and appears to be a localized area of deposition. In addition, comparison of the Year 10 and Year 12 surveys shows consistent conditions in cap surface elevation between the 2016 and 2018 surveys (Figure 20).

Figure 27 presents the comparison between the baseline, Year 2, Year 10 and Year 12 elevations at the cross section location O-O'. The surface elevation at 10-foot intervals along the slope of the cross section, as well as the difference between the baseline and Year 2, and the Year 12 elevations and between the Year 10 and Year 12 elevations, are shown on the bottom of the section. The comparison of the Year 2 survey with the Year 12 multibeam survey along the shoreline of RA 19B shows that the largest difference in Year 12 capped surface is an increase of 0.9 feet in one location when compared to the Year 2 surface. The comparison of Year 2 to Year 12 multibeam surveys otherwise show stable to increased cap elevations.

Along the shoreline between approximate Station 68+80 and Station 70+10, there is an area where the decrease in the cap surface elevation is greater than six inches but less than one foot, with a few limited areas (< 5 feet wide) of cap surface elevation decreases greater than 1 foot (Figure 18) between the Year 12 and baseline surveys. This decrease is not present when comparing Year 2 to Year 12. Comparison of the Year 10 and Year 12 surveys (Figure 20) shows relatively stable cap elevation, with less than 6 inches of change.

In general, the Year 12 capped surface is within six inches of the baseline post-construction capped surface and within the allowable accuracy of the survey equipment. Decreases in cap elevations were not observed between Year 2 and Year 12 (Figure 19), therefore, no response actions are warranted in the shoreline areas of RA 19B.

3.2.14 Remedial Area 20

The subtidal cap area in RA 20 is located on the eastern side of the Thea Foss Waterway in the area adjacent to the Johnny's Dock and Foss Landing marinas between Station 70+10 and Station 62+50. The subtidal cap area in RA 20 consists of a channel sand cap in the harbor area and a slope cap composed of slope cap filter material, riprap, and habitat mix. The Year 12 survey provided complete coverage of the capped area within RA 20, refer to Figure 16 for the Year 12 survey results.

The baseline survey coverage was limited shoreward of the Johnny's Dock floats between Station 62+20 to Station 63+80 and Station 66+00 to Station 67+00, as well as shoreward of the Foss Landing floats between Station 67+50 to Station 70+00. This limitation in coverage is visible in the comparison of the Year 12 survey to the baseline survey shown in Figure 18.

Over the majority of RA 20, the Year 12 capped surface elevation is within six inches of the baseline and Year 10 surface elevations and within the allowable accuracy of the survey equipment. There are a few, small, localized, non-contiguous points where the change (increase or decrease) in the cap surface elevation from baseline and Year 10 to Year 12 is slightly greater than six inches but less than one foot (Figures 18 and 20). There are two localized areas adjacent to elevation 0 feet MLLW, located around approximate Stations 66+00 and 67+25, where comparison of the Year 12 and Year 10 surveys indicate a decrease in cap elevation of greater than six inches but less than a foot (Figure 20), however when the Year 12 survey is compared to the baseline survey, this area is shown as an area of increased elevation from baseline. This potentially indicates sediment deposition may have occurred after baseline, which then settled or eroded. The localized areas are small and in areas of the shoreline with limited access, and differences between the surveys are potentially attributable to survey comparison artifacts and/or variability such as transducer beam width or latency.

In areas of limited baseline survey coverage, post-construction single beam surveys performed by Manson were reviewed and shoreline slope survey transects were used for comparison between the baseline, Year 10 and Year 12 surveys to evaluate cap surface elevations. The cross section comparison locations are identified on Figures 18 and 20. Two cross section comparisons were performed for the areas adjacent to the Johnny's Dock floats at Station 66+75 and Foss Landing floats at Station 68+50, as shown on Figure 27. In the slope cap areas of RA 20, low tide slope cap inspections are also performed and can be used to supplement the hydrographic survey analysis in areas where hydrographic coverage is limited due to the presence of structures, marina docks, and facilities such as in Johnny's Dock floats between Station 62+20 to Station 63+80 and Foss Landing floats between Station 67+50 to Station 70+00.

Figure 27 presents the comparison between the baseline, Year 2, Year 10 and Year 12 elevations at the cross section locations P-P' and Q-Q'. The surface elevations at 10-foot intervals along the slope of the cross sections and the difference in elevation between the baseline and the Year 10 elevations and between the Year 10 and Year 12 elevations are shown on the bottom of each section. The comparisons of the Year 2 survey with the Year 12 multibeam survey along the shoreline of RA 20 show that the Year 12 capped surface in some locations is up to 0.9 foot higher than the Year 2 surface. There is the same approximate range of variation between the Year 10 and Year 2 comparison, indicating that elevations have remained relatively stable between Year 10 and Year 12.

In general, the Year 12 capped surface elevation in RA 20 is within six inches of the baseline surface elevation and within the allowable accuracy of the survey equipment. There are a few very small, localized, non-contiguous points where the decrease in the cap surface elevation is slightly greater than six inches but less than one foot (Figure 18). As these points are localized, do not represent a contiguous region of elevation change, and are less than one foot, no response actions are warranted in RA 20.

3.2.15 Remedial Area 21

The subtidal cap area in RA 21 is located in the central channel of the Thea Foss Waterway, adjacent to the capped areas within RA 18, RA 19A, and RA 20. The subtidal cap area in RA 21 consists of a channel sand cap. The Year 12, Year 10, and the baseline multibeam surveys provided complete coverage of the capped area within RA 21. Refer to Figure 16 for the Year 12 survey results.

The Year 12 capped surface elevation is generally within six inches of both the baseline surface elevation and the Year 10 surface elevation, which is within the allowable accuracy of the survey equipment (Figures 18 and 20). There are areas of surface elevation increase greater than six inches and in some instances greater than one foot when compared to baseline (Figure 18), indicating some localized deposition has occurred in RA 21. The increases in elevation are associated with sediment deposition from the waterway and Year 12 is consistent with Year 10, therefore, no response actions are warranted for RA 21.

3.2.16 Remedial Area 22

The subtidal cap area in RA 22 is located in the channel, at the southern end of the Thea Foss Waterway, adjacent to the capped areas within RA 19B, RA 20 and RA 21. The subtidal cap area in RA 22 consists of a channel sand cap and a rock buttress to support the cantilevered portion of a submerged sheetpile wall installed by the Utilities at the southern end of the RA. The Year 12, Year 10, and the baseline multibeam surveys provided complete coverage of the capped area within RA 22. Refer to Figure 16 for the Year 12 survey results.

The Year 12 capped surface elevation for the channel sand cap area is generally within six inches of both the baseline surface elevation and the Year 10 surface elevation, which is within the allowable accuracy of the survey equipment (Figures 18 and 20). Therefore, no response actions are warranted.

The eastern portion of the rock buttress adjacent to the sheetpile wall indicates a decrease in elevation of greater than six inches and in places greater than one foot but less than 18 inches when comparing the Year 12 surface elevation to the baseline surface elevation (Figure 18). In this same location, a comparison of the Year 12 surface elevation to the Year 10 surface elevation shows a change in elevation of less than six inches (Figure 20). As the rock buttress is up to 10 feet high in this area, a potential decrease in elevation that is less than one foot does not warrant evaluation of response actions.

3.3 MURRAY MORGAN (11TH STREET) BRIDGE REMEDIAL ACTION SURVEYS

Between 2011 and 2013, the City completed a rehabilitation project of the MMB, which crosses the Thea Foss Waterway at Station 35+00. As part of this project, pre- and post-construction surface sediment sampling were performed under and adjacent to the MMB, which identified metals impacts to the surface sediments believed to be the result of the rehabilitation construction activities. A remedial action was subsequently performed in this area between February 5 and February 14, 2015. A detailed description of the remedial action and outcomes are presented in the Remedial Action Construction Report (RACR) submitted to EPA in August 2015 (Floyd|Snider 2015).

The contaminated sediments were present in an approximately 3,000 square foot area underlying the western portion of the bridge at a depth of approximately -25 feet to -30 feet MLLW and were addressed by dredging of a minimum of 6 inches of sediments followed by thin-layer capping of the area with clean sand to the existing pre-remedial action surface. A multi-beam hydrographic survey was conducted prior to remedial activities to determine the existing surface of the remedial area. Post-remedial action, a multi-beam hydrographic survey was conducted to confirm final cap thickness at 6 inches or greater, and elevation of the remedial area. This multi-beam hydrographic survey indicated that in some areas the required 6 inches of cap material had not been placed and low spots were observed, requiring additional cap placement. With EPA approval, a hydrographic survey was not required to be repeated following the additional capping. Instead, lead line soundings were collected throughout the newly capped areas; which indicated that sufficient cap material was placed to achieve the remedial action objective. The lead line measurements were then merged with the post-remedial action hydrographic survey data to confirm the final cap thickness and remedial area surface elevation.

3.3.1 Comparability of Post-Construction Survey and Establishing Baseline

The MMB remedial action area is now required to be monitored as part of LTMP activities in order to confirm that the required 6 inch cap thickness is maintained. Therefore, as part of the Year 10 hydrographic survey in 2016, the MMB RA was surveyed to provide a Year 1 sediment surface elevation and to provide a comparison with the elevation of the post-construction surface completed by the contractor in February 2015. It is important to note that the MMB remedial action was completed in 2015, so the survey years for MMB are applied accordingly since this construction completion date; the 2016 survey was Year 1 and the 2018 survey is Year 3. The 2016 multibeam survey completed by DEA provided complete coverage of the capped area under the MMB. The final post-construction cap thickness (in inches) in 2015, along with a comparison of surface elevation changes between the post-construction survey in 2015 and the 2016 hydrographic survey are presented on Figure 28.

Figure 28 shows that the cap surface has increased in thickness across the remedial action area, but in general the changes in the cap surface elevation are within 6-inches of the final cap surface in 2015. Overall increases in cap thickness across the remedial action area in 2016 showed that the cap surface had leveled out since it was placed in 2015. Consistent with the RACR, the spreading and settling of the cap placement was expected to occur over time due to currents and the sloping nature of the dredge area. The cap thickness was generally significantly greater (up to 37 inches) than the required 6-inches in areas where settling was observed.

The post-construction survey for MMB included a combination of multibeam surveys merged with lead line measurement data. This post-construction survey used a different datum and different survey control points than DEA's multibeam hydrographic surveys in 2016 and 2018. Due to the lack of direct comparability, and the observed spreading and settling of the cap between the time it was placed in February 2015 and the March 2016 multibeam survey completed by DEA one year later, there is better comparability with using the 2016 (Year 1 for MMB) multibeam survey as the baseline comparison moving forward. Therefore, the Year 1(2016) survey is used for the baseline comparison in Section 3.3.2 below, and will be used as baseline for subsequent LTMP surveys for better overall comparability.

3.3.2 Comparison of Baseline (Year 1, 2016) and 2018 Hydrographic Surveys

The MMB RA subtidal cap area in in the central portion of the channel and crosses the Thea Foss Waterway at Station 35+00, east of the capped areas within RA 7A. The subtidal cap area in the MMB RA consists of a channel sand cap. The Year 3 (2018) survey and the baseline Year 1 (2016) multibeam survey provided complete coverage of the MMB RA capped area. Refer to Figure 17 for the Year 12 survey results.

The Year 3 (2018) capped surface elevation for the channel sand cap area is generally within six inches of the baseline (Year 1) surface elevation, which is within the allowable accuracy of the survey equipment (Figures 20 and 29). There is one very small (less than 7 sf) and localized area where a decrease in cap elevation greater than six inches but less than one foot was observed. This decrease is in an area where an increase in cap elevation was previously observed between 2015 and 2016 (Figure 28), therefore, no response actions are warranted.

4.0 Summary of Preliminary Findings

The following summarizes the preliminary findings from the Year 12 hydrographic survey and comparison of the Year 12 survey to the baseline (or Year 2 where limited baseline survey data are available) and Year 10 surveys:

- Nearly complete coverage of the subtidal slope, grout mat, and channel sand cap areas was achieved in the Year 12 hydrographic survey. There was a fairly large area that could not be surveyed in RA14 due to the presence of a large vessel in front of the former Martinac facility (see Attachment C for photographs).

- The Year 12 hydrographic survey was performed using equipment and procedures comparable to prior hydrographic surveys performed under the OMMP; a smaller survey vessel was used in Year 12. The use of a smaller and more maneuverable survey vessel in Year 12 provided better coverage along some shoreline slopes and, in some instances, provided coverage in areas that could not fully be surveyed during past events due to obstructions such as floats or vessels.

- Single beam baseline transect lines were used, where available, in shoreline areas of limited baseline multibeam survey coverage to aid in evaluating cap surface elevations.

- Low tide slope cap inspections will be used to supplement the hydrographic survey analysis of shoreline slope cap areas where baseline hydrographic survey coverage is limited due to the presence of structures, marina docks and facilities and/or where changes in the cap elevations were indicated at or shallower than 0 feet MLLW.

- In shoreline slope areas that were inaccessible or blocked by large vessels, floats or obstructions, the baseline multibeam survey had to use wider sonar angles along the slopes and to reach under such obstructions, which can result in less accurate readings. Variances identified in shoreline slope areas with limited baseline survey coverage are potentially due in part to the wider sonar angles that were necessary to reach under obstructions during the baseline survey.

- In general, the Year 12 cap surface elevations are within six inches of the baseline surface elevation and within the allowable accuracy of the survey equipment.

- A comparison of the Year 10 to the Year 12 survey shows that the elevations in most areas have remained fairly consistent and stable during the past two years.

- There are limited areas where the decrease in the cap surface elevation from baseline to Year 12 is greater than six inches but less than one foot. These areas are generally small, localized, and non-contiguous and do not warrant response actions.

4.1 PROPOSED RESPONSE ACTIONS

Based on the results of the Year 12 2018 hydrographic survey and comparison of the data with the previous Year 10 (2016) and baseline or Year 2 results as described in Section 3.0 above, there are no proposed response actions for the subtidal cap area. Low tide slope cap inspections will be performed in accordance with the LTMP and will be used to supplement the hydrographic survey analysis in areas where complete hydrographic coverage was limited (such as RA 14).

4.2 FUTURE HYDROGRAPHIC SURVEY ANALYSES

All RAs have been evaluated for cap integrity in Years 2, 4, 7, and 10 following remedial action construction in accordance with the OMMP and in Year 12 in accordance with the LTMP. In general, the RAs have been stable with most Year 12 cap surface elevations within six inches of the baseline or Year 2 surface elevation and within the allowable accuracy of the survey equipment. Future hydrographic survey monitoring will be conducted as part of the LTMP in Years 17 (2022) and 22 (2027).

Additional cap integrity monitoring of the subtidal cap areas may also be warranted in select cap areas if a natural or unforeseen incident occurs and is determined to have potentially adverse impacts on the cap integrity. This could include, but is not limited to: a storm event that has led to shoreline failure, such as erosion or a landslide; a marine incident that disturbs the cap surface, such as a vessel grounding or dragging an anchor; or a seismic event where other physical changes have been observed within the City of Tacoma. Performance of any supplemental cap integrity monitoring will be coordinated with the EPA.

TABLES

FIGURES

ATTACHMENTS

Table 1
Summary of Completed Remedial Actions, Descriptions, and Remedial Areas

Action	Action Description	Remedial Areas (RA)
Natural Recovery	Areas that are not designated for active remedial action because the area was expected to recover naturally (i.e., surface sediment concentrations to meet the Sediment Quality Objectives [SQOs]) within 10 years of completion of sediment remedial action.	RA NR-1, RA NR-2, RA NR-3, RA NR-4, and northern portions of RA 5, RA 6, and RA 7
Enhanced Natural Recovery	Placement of a thin layer (i.e., six inches) of clean material (i.e., channel sand cap material) to facilitate natural recovery in the 10 years following completion of the remedial action.	RA 7
Dredged to Clean	Removal of sediment with contaminant concentrations greater than the SQOs at the final dredge surface.	RA 5, RA 6, RA 16, and RA 17
Dredged and Backfilled[1]	Placement of channel sand cap material to meet the surrounding grade (i.e., surrounding sediment surface elevation) in an area where dredging has removed sediment with contaminant concentrations greater than the SQOs.	RA 2, RA 4, and RA 12
Channel Sand Cap	Placement of a minimum of 3 feet of channel sand cap material composed of imported sand (i.e., 100 percent passing the 3/8-inch sieve size, 85 to 100 percent passing the No. 4 sieve size, and 25 to 45 percent passing the No. 10 sieve size) from an upland quarry to confine underlying sediment with contaminant concentrations greater than the SQOs.	RA 1A, RA 6, RA 7A, RA 9, RA 16, RA 17, RA 18, RA 19A, RA 19B, RA 20, RA 21, RA 22, and the sheen source removal area in RA 12
Slope Cap	Placement of a minimum of 18 inches of slope cap filter material composed of imported sand and gravel (i.e., 100 percent passing the 6-inch sieve size, 35 to 65 percent passing the No. 4 sieve size, and 15 to 45 percent passing the No. 10 sieve size) from an upland quarry as a confining layer, followed by placement of a minimum of 18 inches of armoring (i.e., riprap or quarry spalls), followed by placement of habitat mix on the surface of the armoring layer. Habitat mix is composed of an imported sand and gravel (i.e., 100 percent passing the 2-inch sieve size, 40 to 60 percent passing the No. 4 sieve size, and 30 to 50 percent passing the No. 10 sieve size) supplied by an upland quarry.	RA 1B, RA 3, RA 5, RA 8, RA 14, RA 19A, RA 19B, and RA 20

Table 1
Summary of Completed Remedial Actions, Descriptions, and Remedial Areas

Action	Action Description	Remedial Areas (RA)
Grout Mat Cap	A mat placed to confine sediment with contaminant concentrations greater than the SQOs that is composed of one or two 6-inch-thick layers of concrete, established by injecting grout into a fabric sheath that has been placed over a remedial area.	RA 3, RA 19A, RA 19B
Thin-Layer Sand Cap	Placement of a thin layer (i.e., six inches) of clean material (i.e., channel sand cap material) following dredging to return this area back to the original mudline elevation and to cover remaining elevated sediment concentrations for metals on the post-dredge surface.	Murray Morgan Bridge Remedial Action Area
Habitat Enhancement[1]	Modification to an existing shoreline area to enhance habitat development that may include constructing a benched area at a specific elevation, modifying the substrate, and/or installing large woody debris and/or plants.	RA 8, RA 20, and at the head of the Thea Foss Waterway
Slope Rehabilitation[1]	Removal of anthropogenic debris (e.g., concrete, piling, etc.) and/or placement of import material (e.g., armoring, habitat mix, etc.) to stabilize, flatten, and/or provide more suitable habitat.	RA 10, RA 11, RA 13, and RA 15

Note:
1 Completed action was not constructed for chemical containment and is not included in Long-Term Monitoring Plan cap integrity monitoring requirements.

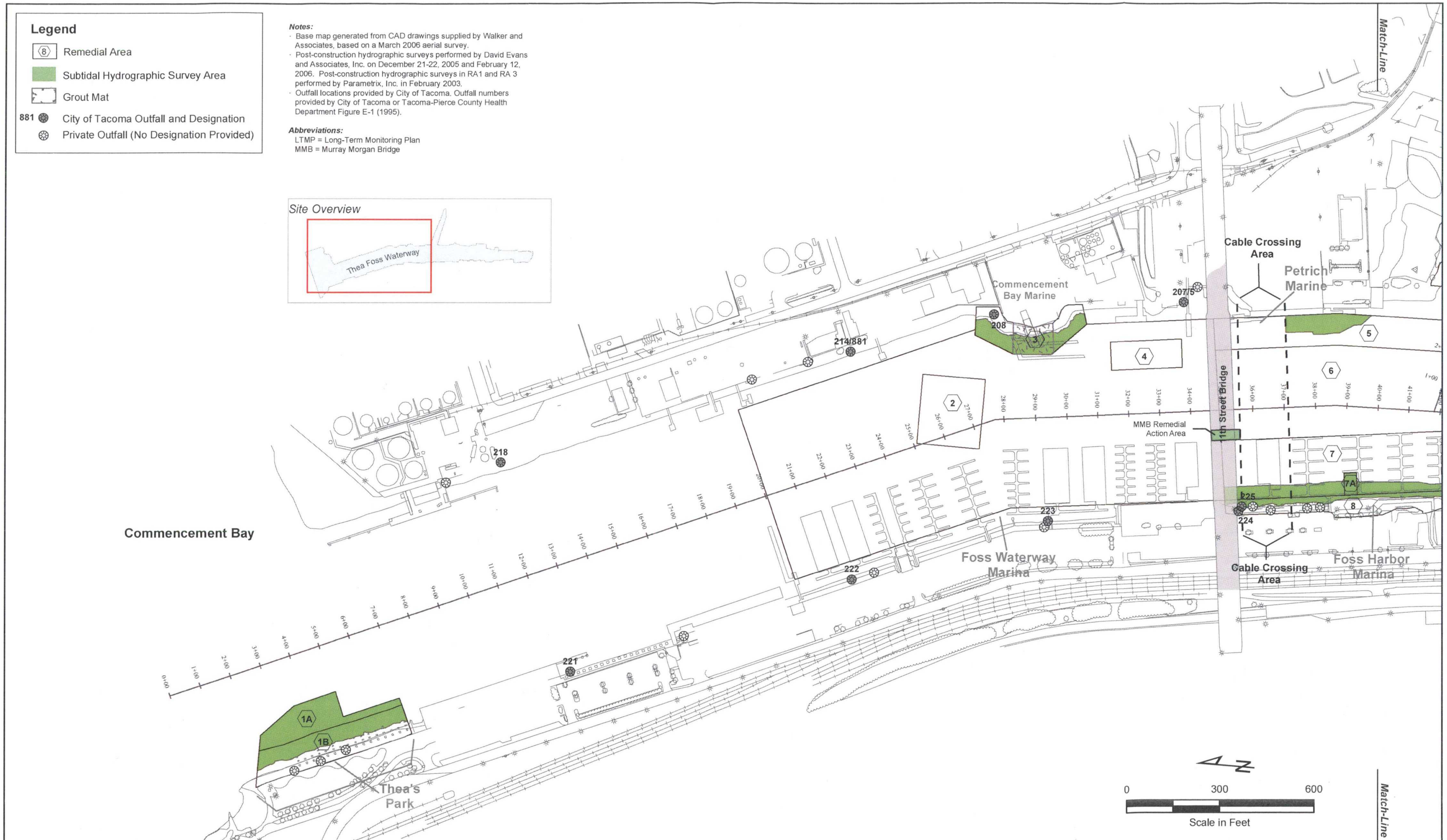
Table 2
Summary of Subtidal Cap Hydrographic Surveys
Thea Foss and Wheeler-Osgood Waterways

Survey Event	Date	Performed by	Survey Type and Details	Survey Notes
Baseline (RA 1 and RA 3)	February 2003	Manson Construction Company (survey) and Parametrix (survey data processing); survey was conducted aboard the Manson Vessel *Bub*.	Single-Beam: Depth soundings were acquired with an Innerspace single frequency fathometer using a frequency of 448 kilo hertz (kHz).	2003 post-construction baseline single beam hydrographic surveys were performed in accordance with USACE manual standards.
Baseline (RA 5, RA 6, RA 7A, RA 8, RA 9, RA 14, RA 16, RA 17, RA 18, RA 19A, RA 19B, RA 20, RA 21 and RA 22)	December 2005 and February 2006	David Evans and Associates (survey and data processing); survey was conducted aboard DEA's 33-foot vessel *John B Preston*.	Multi-beam: Soundings were acquired with a Reson SeaBat 8101 Extended Range multibeam bathymetric sonar using a frequency of 240 kHz.	In many areas, obstructions from construction activities prevented the vessel from surveying close to the shoreline. Several areas were inaccessible or blocked by large vessels, floats or other obstructions.
Year 2 (OMMP)	March 2008	David Evans and Associates (survey and data processing); survey was conducted aboard DEA's 33-foot vessel *John B Preston*.	Multi-beam: Soundings were acquired with a Reson SeaBat 8101 Extended Range multibeam bathymetric sonar using a frequency of 240 kHz.	Construction activities were not occurring during the Year 2 survey and as a result the vessel was able to survey closer to the shoreline than during post-construction baseline surveys.
Year 4 (OMMP)	March 2010	David Evans and Associates (survey and data processing); survey was conducted aboard DEA's 33-foot vessel *John B Preston*.	Multi-beam: Soundings were acquired with a Reson SeaBat 8101 Extended Range multibeam bathymetric sonar using a frequency of 240 kHz.	The control point (#2014) used in Year 2 survey was found to be destroyed, and was not available for use in the Year 4 survey. Collection of additional positioning data from three additional control points in the area allowed for valid adjustment to the data during post processing.
Year 7 (OMMP)	April 2013	David Evans and Associates (survey and data processing); survey was conducted aboard DEA's 33-foot vessel *John B Preston*.	Multi-beam: Soundings were acquired with a Reson SeaBat 8101 Extended Range multibeam bathymetric sonar using a frequency of 240 kHz.	There was a large fishing boat under construction at Martinac Shipyard that limited the extent of survey coverage in RA-14.
Year 10 (OMMP); Year 1 for Murray Morgan Bridge (MMB) RA	March 2016	David Evans and Associates (survey and data processing); survey was conducted aboard DEA's 33-foot vessel *John B Preston*.	Multi-beam: Soundings were acquired with a Reson SeaBat 7125 SV2 dual frequency multibeam sonar using a frequency of 400 kHz	The change to the Reson SeaBat 7125 offered an increase in both data density and resolution which allowed for better data quality and coverage during this survey.
Year 12 (LTMP); Year 3 for MMB RA	March 2018	David Evans and Associates (survey and data processing); survey was conducted aboard DEA's 19-foot vessel *River Hawk*.	Multi-beam: Soundings were acquired with a Reson SeaBat 7101 multibeam bathymetric sonar using a frequency of 240 kHz	A smaller vessel was used for the survey, which provided better access to shoreline areas and better coverage. There was a large vessel moored at the former Martinac Shipyard that limited the extent of survey coverage in RA-14.

Notes:

Table 2
Summary of Subtidal Cap Hydrographic Surveys
Thea Foss and Wheeler-Osgood Waterways

1. Hydrographic surveys completed for Baseline and in Years 2, 4, 7, and 10 were completed in accordance with the Operations, Maintenance, and Monitoring Plan (OMMP) for the Thea Foss and Wheeler-Osgood Waterways Remediation Project (City of Tacoma 2006).
2. The hydrographic survey completed in Year 12 (2018) was completed in accordance with the Physical Cap Integrity Operations Manual included as Appendix A of the *Thea Foss and Wheeler-Osgood Waterways Long-Term Monitoring Plan* (LTMP; City of Tacoma, 2018).



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Thea Foss and Wheeler-Osgood Waterways
LTMP

Figure 1 (Page 1 of 2)
Subtidal Hydrographic Survey Areas

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5/8/2018

Thea Foss and Wheeler-Osgood Waterways
LTMP

Figure 1 (Page 2 of 2)
Subtidal Hydrographic Survey Areas

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5/8/2018

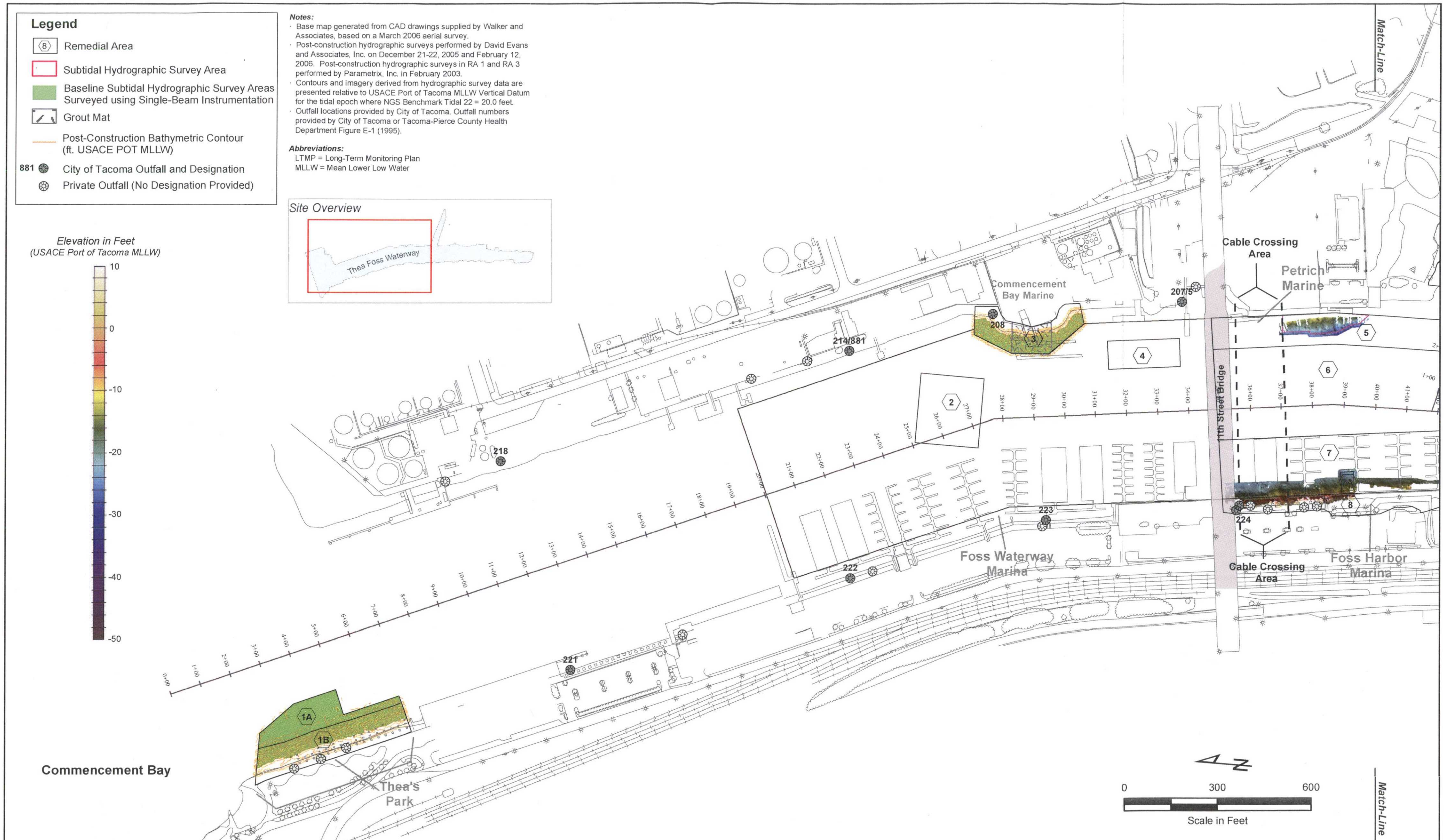

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**Figure 2 (Page 1 of 2)
Overview of Baseline Bathymetric Conditions**

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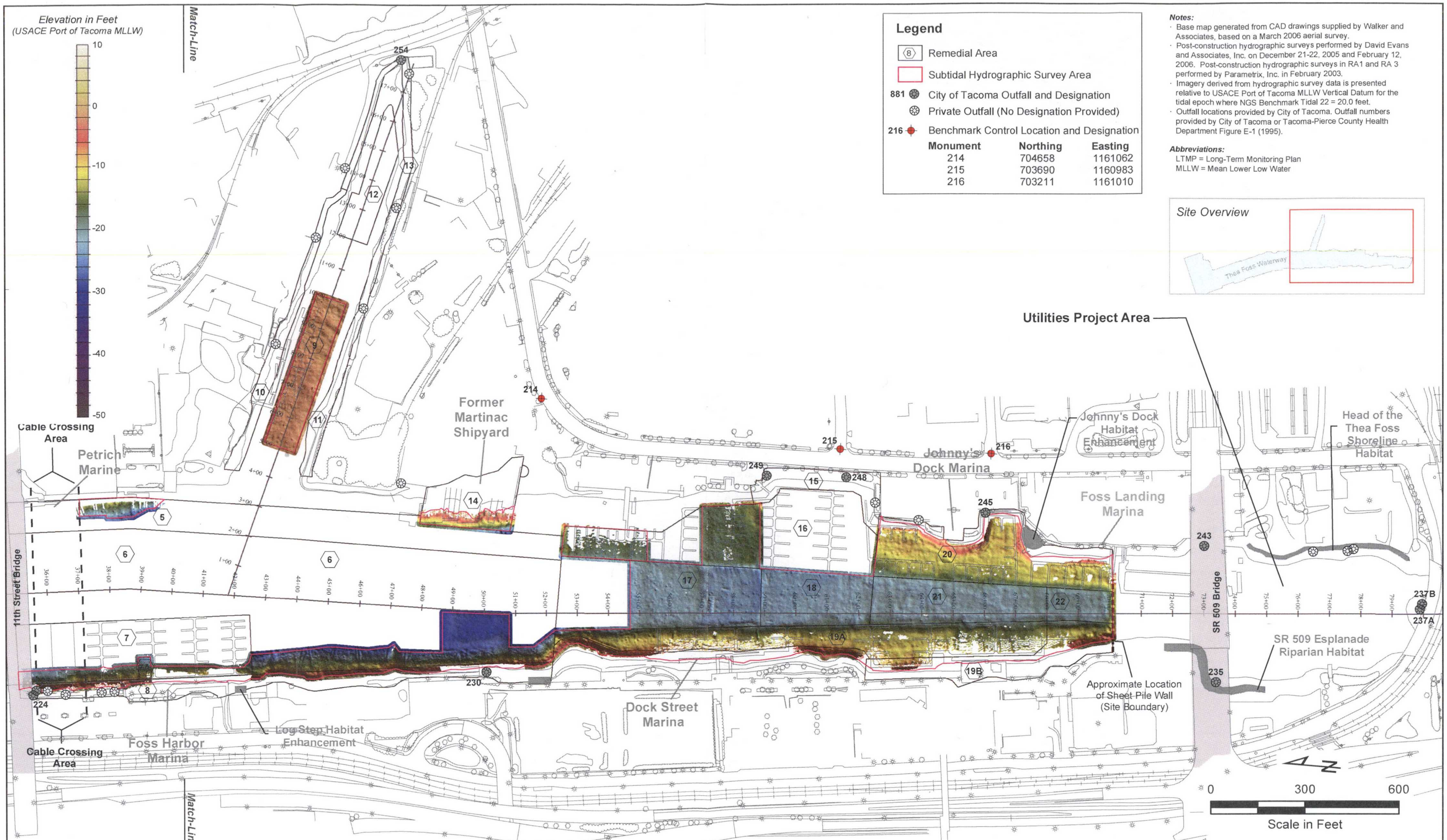
5/8/2018



Legend

- Remedial Area
- Subtidal Hydrographic Survey Area
- 881 City of Tacoma Outfall and Designation
- Private Outfall (No Designation Provided)
- 216 Benchmark Control Location and Designation

Monument	Northing	Easting
214	704658	1161062
215	703690	1160983
216	703211	1161010

Notes:

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic surveys performed by David Evans and Associates, Inc. on December 21-22, 2005 and February 12, 2006. Post-construction hydrographic surveys in RA1 and RA 3 performed by Parametrix, Inc. in February 2003.
- Imagery derived from hydrographic survey data is presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995).

Abbreviations:

LTMP = Long-Term Monitoring Plan
MLLW = Mean Lower Low Water

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Figure 2 (Page 2 of 2)
Overview of Baseline Bathymetric Conditions

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5/8/2018

Legend

- Remedial Area
- Subtidal Hydrographic Survey Area
- Grout Mat
- 881 City of Tacoma Outfall and Designation
- Private Outfall (No Designation Provided)

Notes:

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Year 2 (2008) multibeam hydrographic survey performed by David Evans and Associates, Inc. on March 5 and 6, 2008.
- Imagery derived from hydrographic survey data is presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995).

Abbreviations:

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MLLW = Mean Lower Low Water

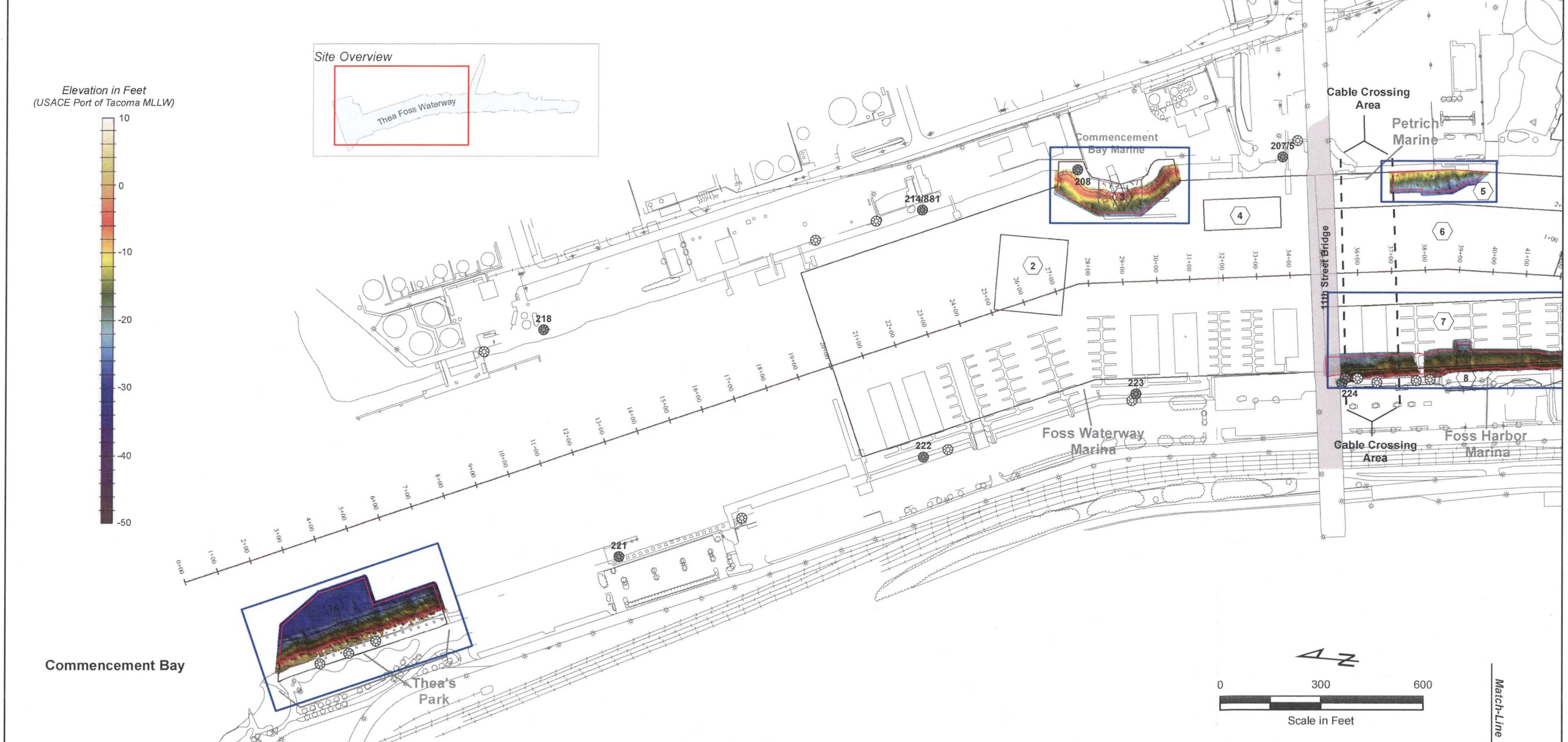

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Figure 3 (Page 1 of 2)
Overview of Year 2 (2008) Bathymetric Conditions

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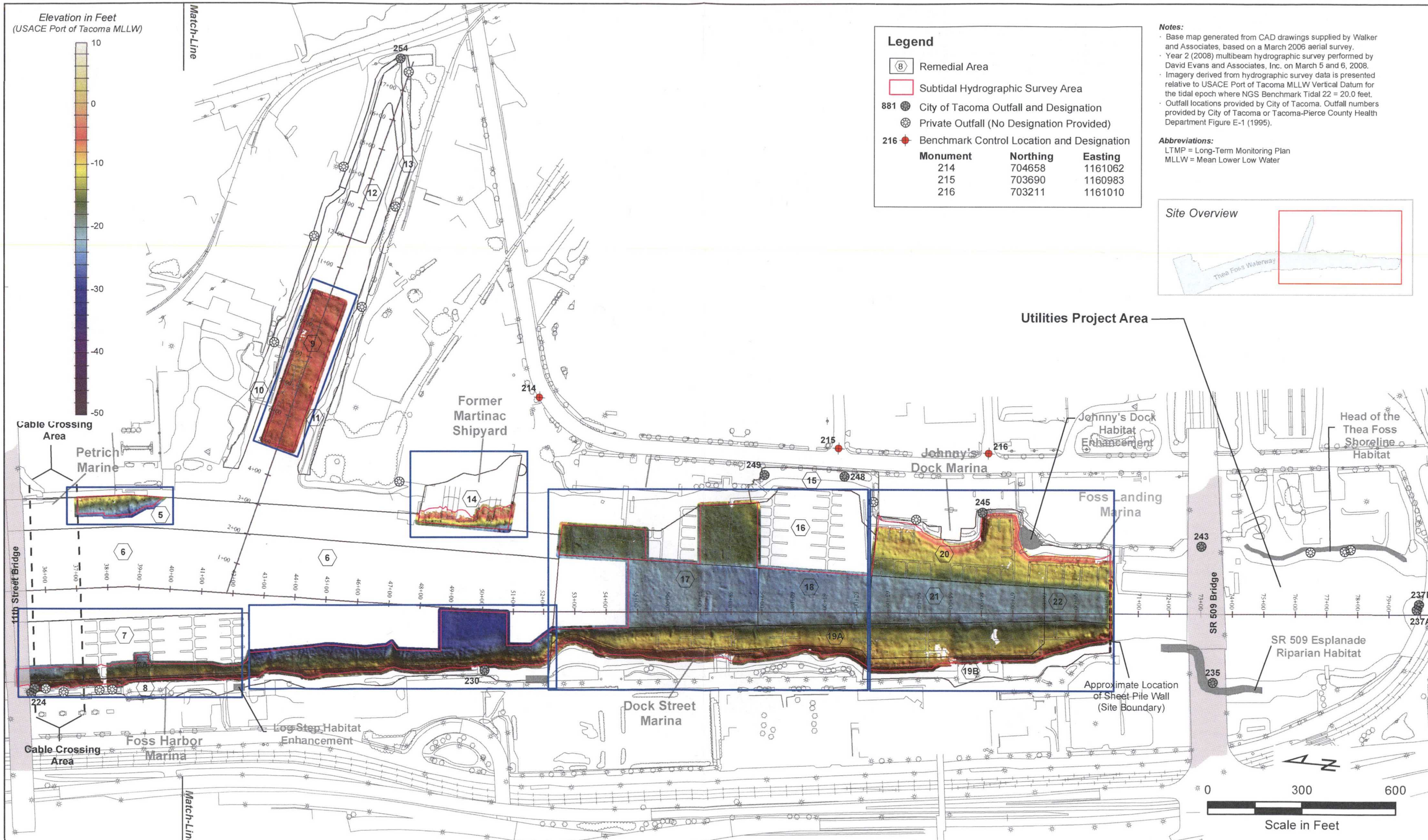

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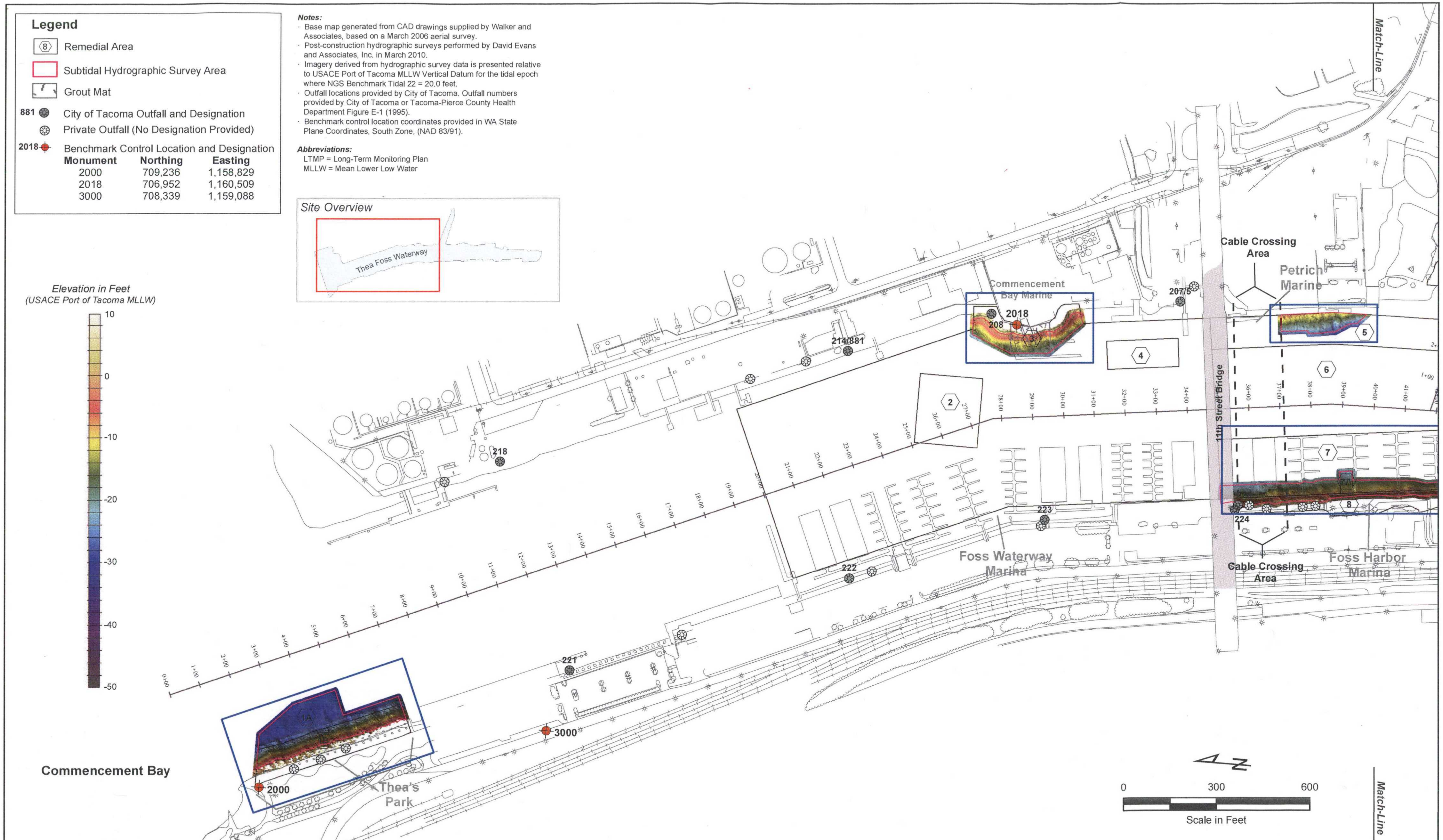
LTMP

Figure 3 (Page 2 of 2)
Overview of Year 2 (2008)
Bathymetric Conditions



Notes:

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic surveys performed by David Evans and Associates, Inc. in March 2010.
- Imagery derived from hydrographic survey data is presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995).
- Benchmark control location coordinates provided in WA State Plane Coordinates, South Zone, (NAD 83/91).

Abbreviations:

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MLLW = Mean Lower Low Water

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LTMP

Figure 4 (Page 1 of 2)
Overview of Year 4 (2010) Bathymetric Conditions

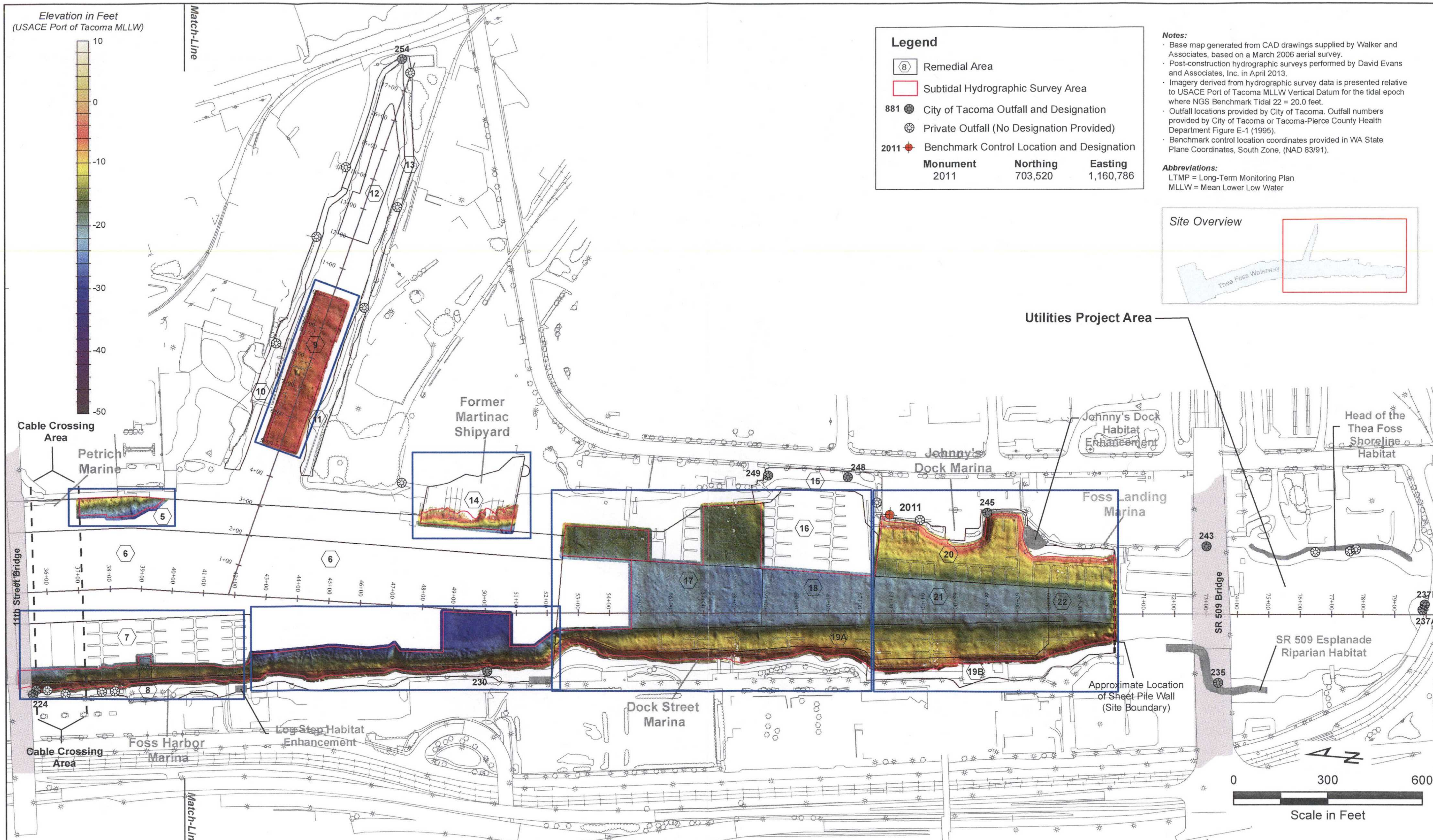

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Figure 4 (Page 2 of 2)
Overview of Year 4 (2010) Bathymetric Conditions

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5/8/2018

Legend

- (8) Remedial Area
- Subtidal Hydrographic Survey Area
- Grout Mat
- 881 City of Tacoma Outfall and Designation
- Private Outfall (No Designation Provided)
- 2018 Benchmark Control Location and Designation

Monument	Northing	Easting
2000	709,236	1,158,829
2018	706,952	1,160,509
3000	708,339	1,159,088

Notes:

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic surveys performed by David Evans and Associates, Inc. in April 2013.
- Imagery derived from hydrographic survey data is presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995).
- Benchmark control location coordinates provided in WA State Plane Coordinates, South Zone, (NAD 83/91).

Abbreviations:

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MLLW = Mean Lower Low Water

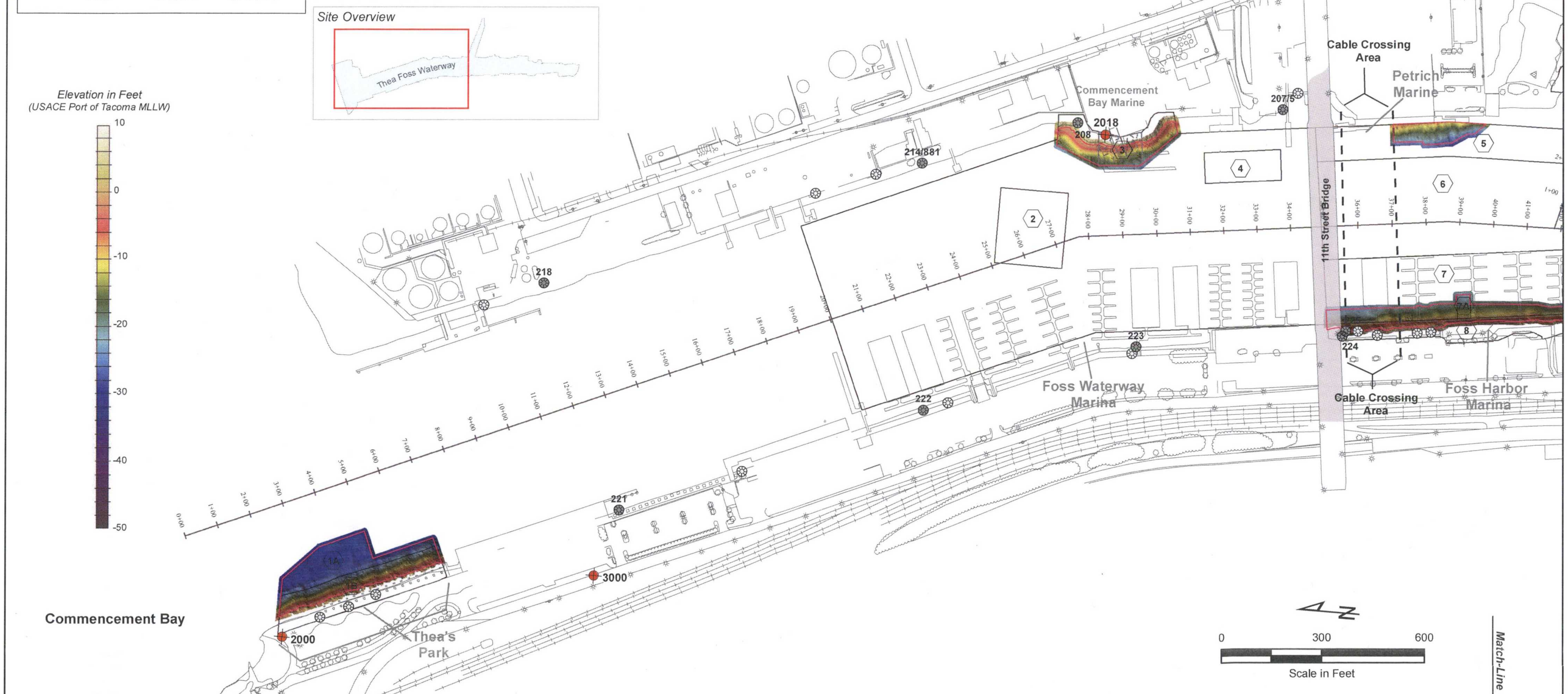

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Figure 5 (Page 1 of 2)
Overview of Year 7 (2013) Bathymetric Conditions

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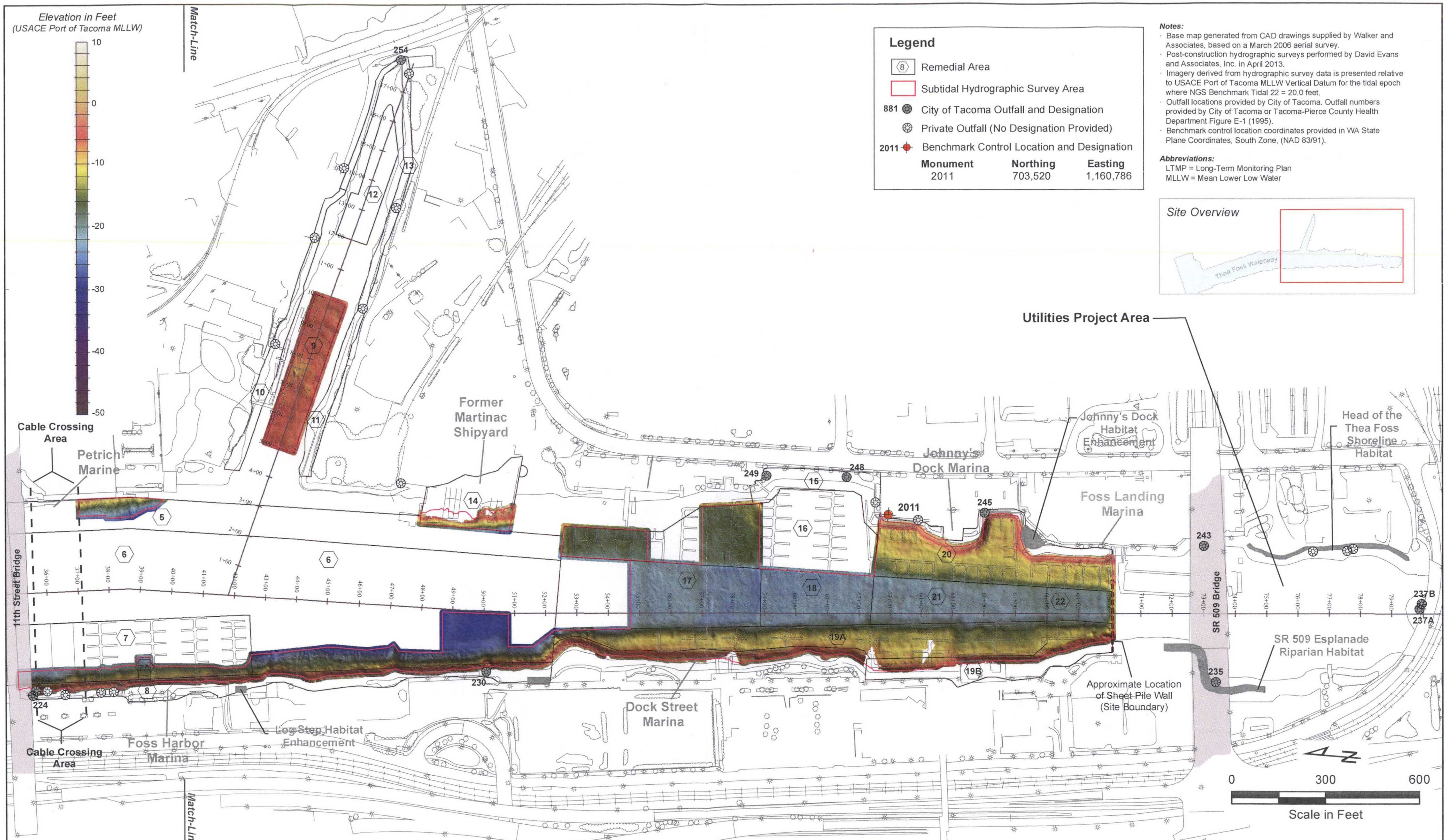

Notes:
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- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995).
- Benchmark control location coordinates provided in WA State Plane Coordinates, South Zone, (NAD 83/91).

Abbreviations:
LTMP = Long-Term Monitoring Plan
MLLW = Mean Lower Low Water

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Figure 5 (Page 2 of 2)
Overview of Year 7 (2013) Bathymetric Conditions

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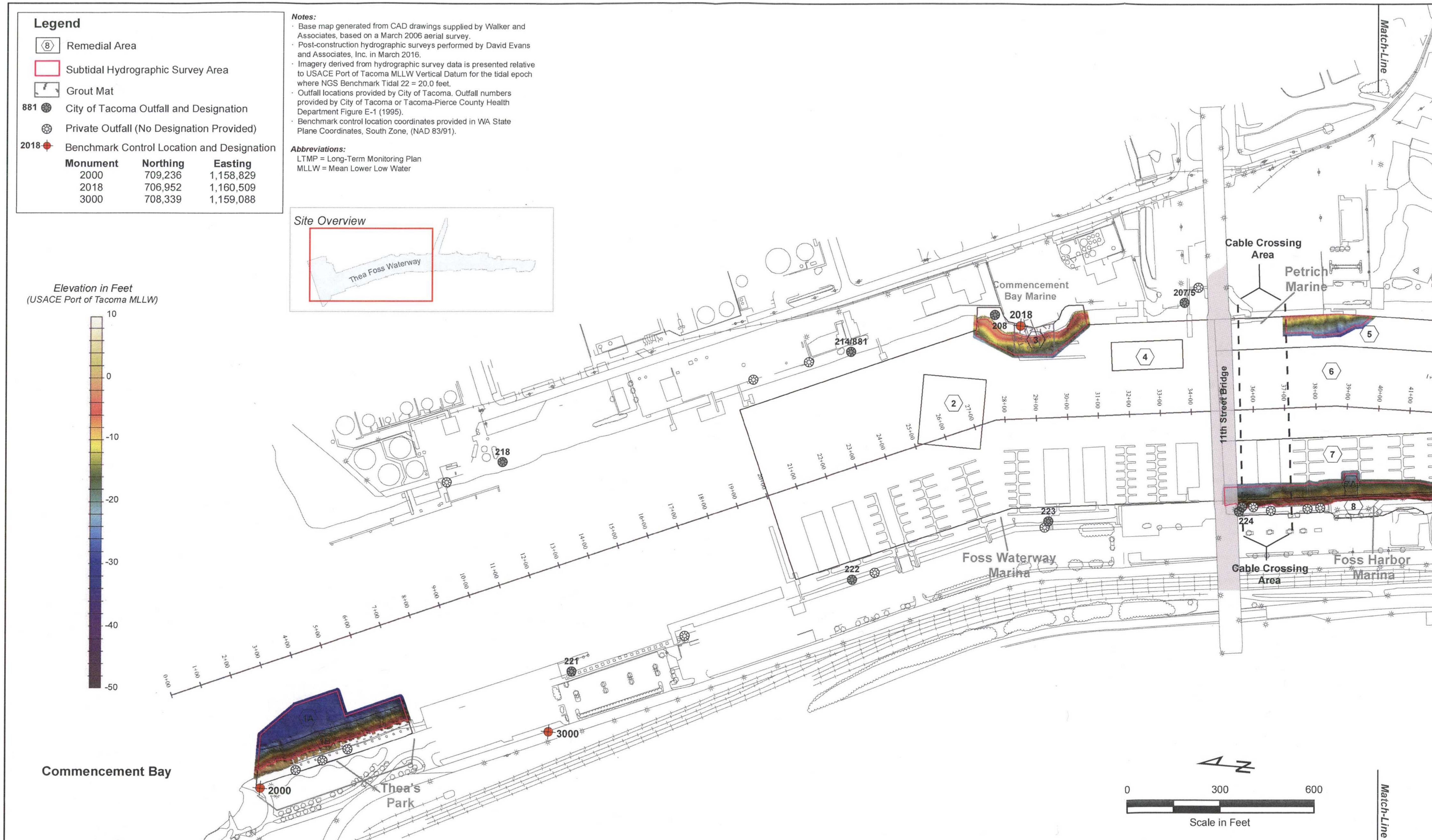

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Figure 6 (Page 1 of 2)
Overview of Year 10 (2016) Bathymetric Conditions

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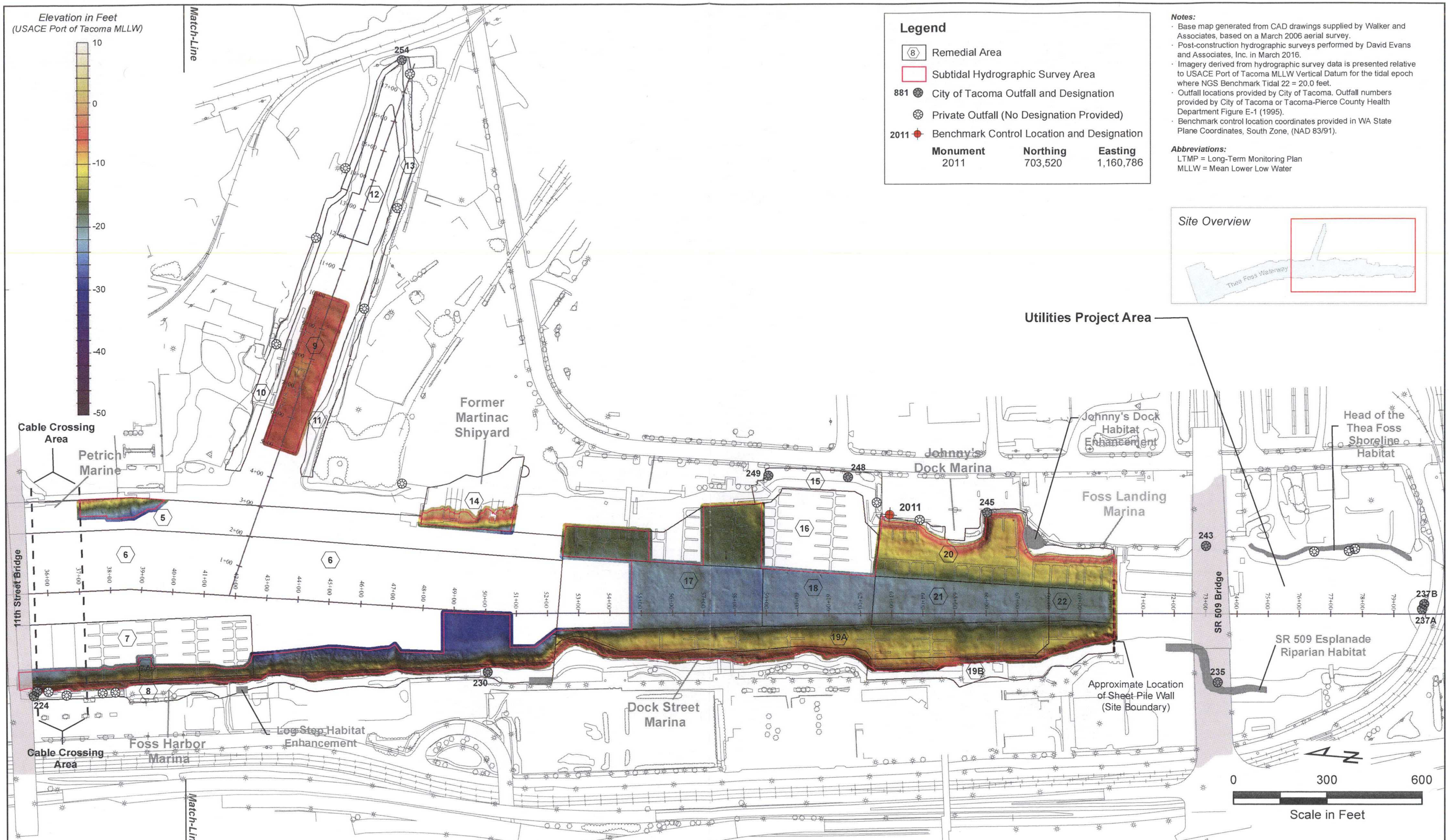

Notes:

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic surveys performed by David Evans and Associates, Inc. in March 2016.
- Imagery derived from hydrographic survey data is presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995).
- Benchmark control location coordinates provided in WA State Plane Coordinates, South Zone, (NAD 83/91).

Abbreviations:

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MLLW = Mean Lower Low Water

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Figure 6 (Page 2 of 2)
Overview of Year 10 (2016) Bathymetric Conditions

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5/14/2018

Legend

- Remedial Area
- Subtidal Hydrographic Survey Area
- Grout Mat
- 881 City of Tacoma Outfall and Designation
- Private Outfall (No Designation Provided)
- 2018 Benchmark Control Location and Designation

Monument	Northing	Easting
2000	709,236	1,158,829
2018	706,952	1,160,509
3000	708,339	1,159,088

Notes:
- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic surveys performed by David Evans and Associates, Inc. in March 2018.
- Imagery derived from hydrographic survey data is presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995).
- Benchmark control location coordinates provided in WA State Plane Coordinates, South Zone, (NAD 83/91).

Abbreviations:

LTMP = Long-Term Monitoring Plan
MLLW = Mean Lower Low Water
MMB = Murray Morgan Bridge

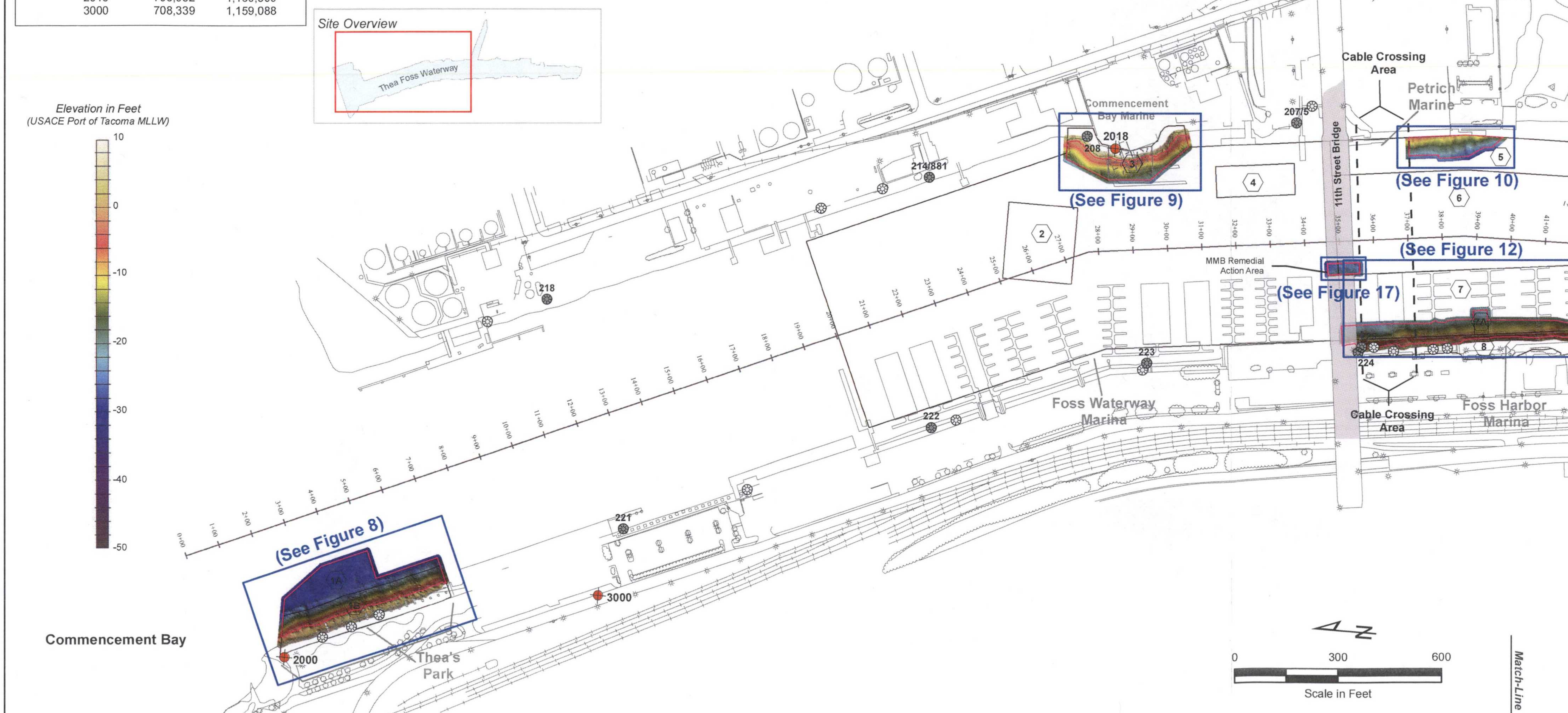

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Figure 7 (Page 1 of 2)
Overview of Year 12 (2018) Bathymetric Conditions

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5/14/2018

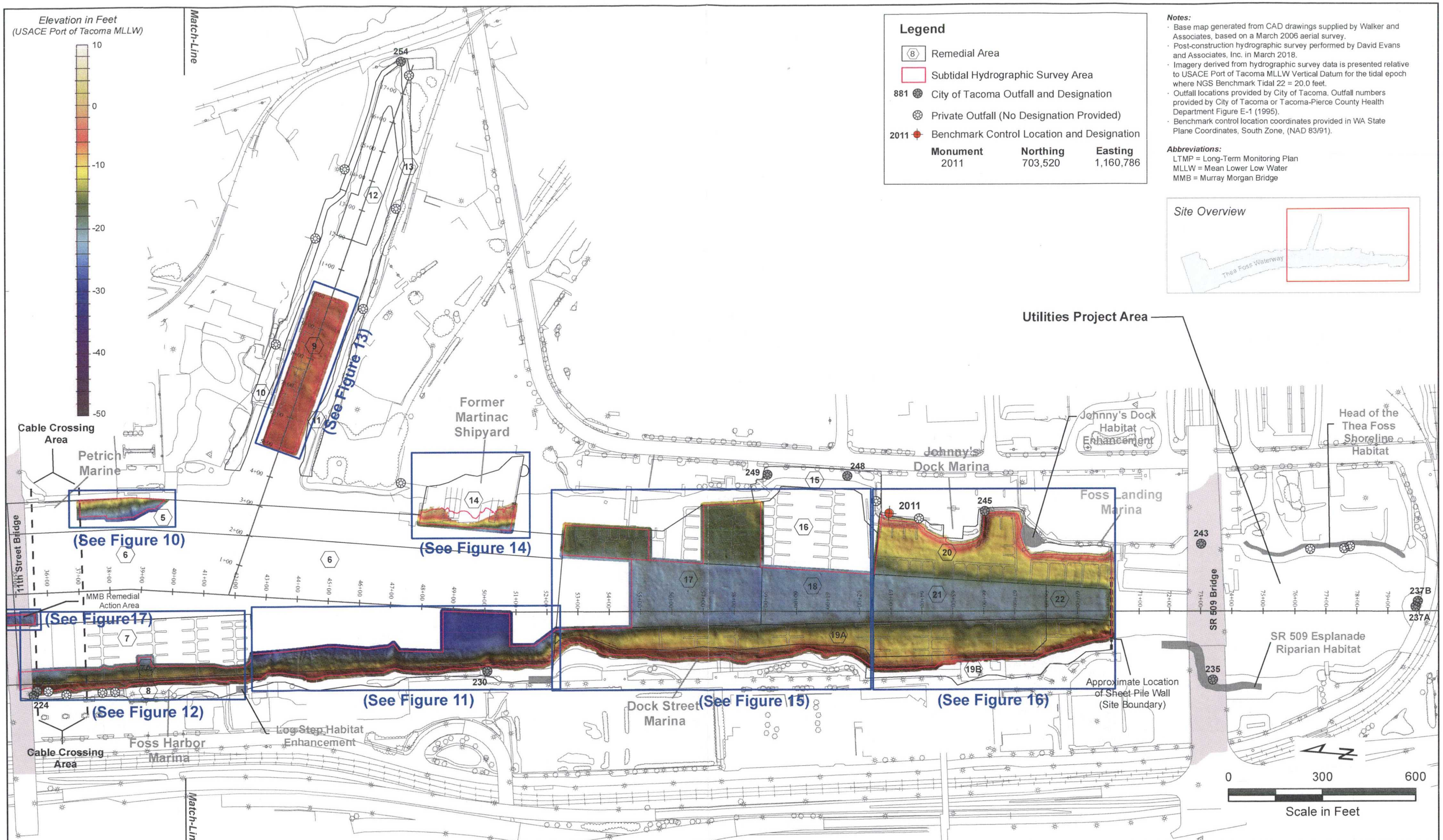

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Figure 7 (Page 2 of 2)
Overview of Year 12 (2018) Bathymetric Conditions

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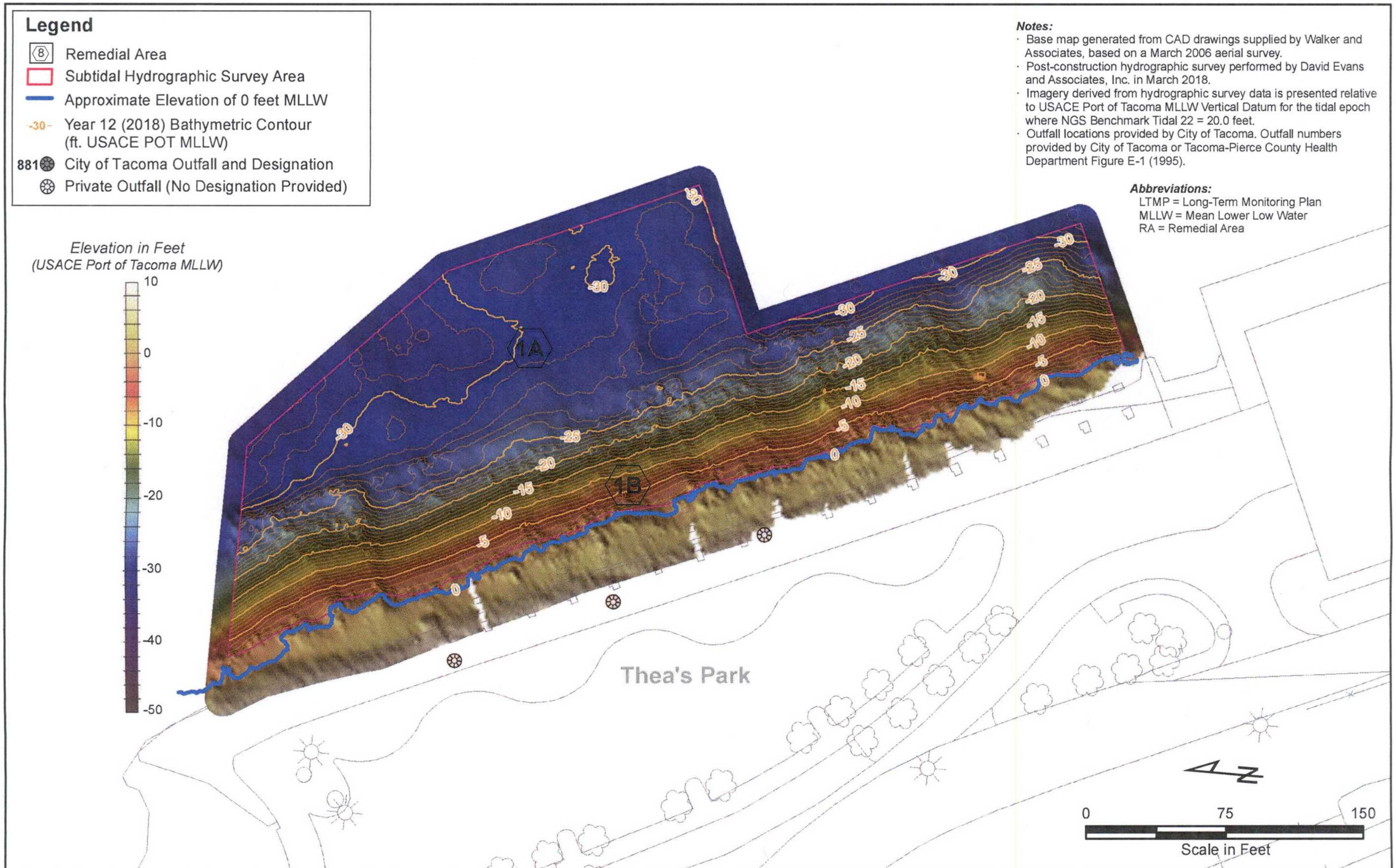

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Figure 8
RA 1 Year 12 (2018) Subtidal Hydrographic Survey Results

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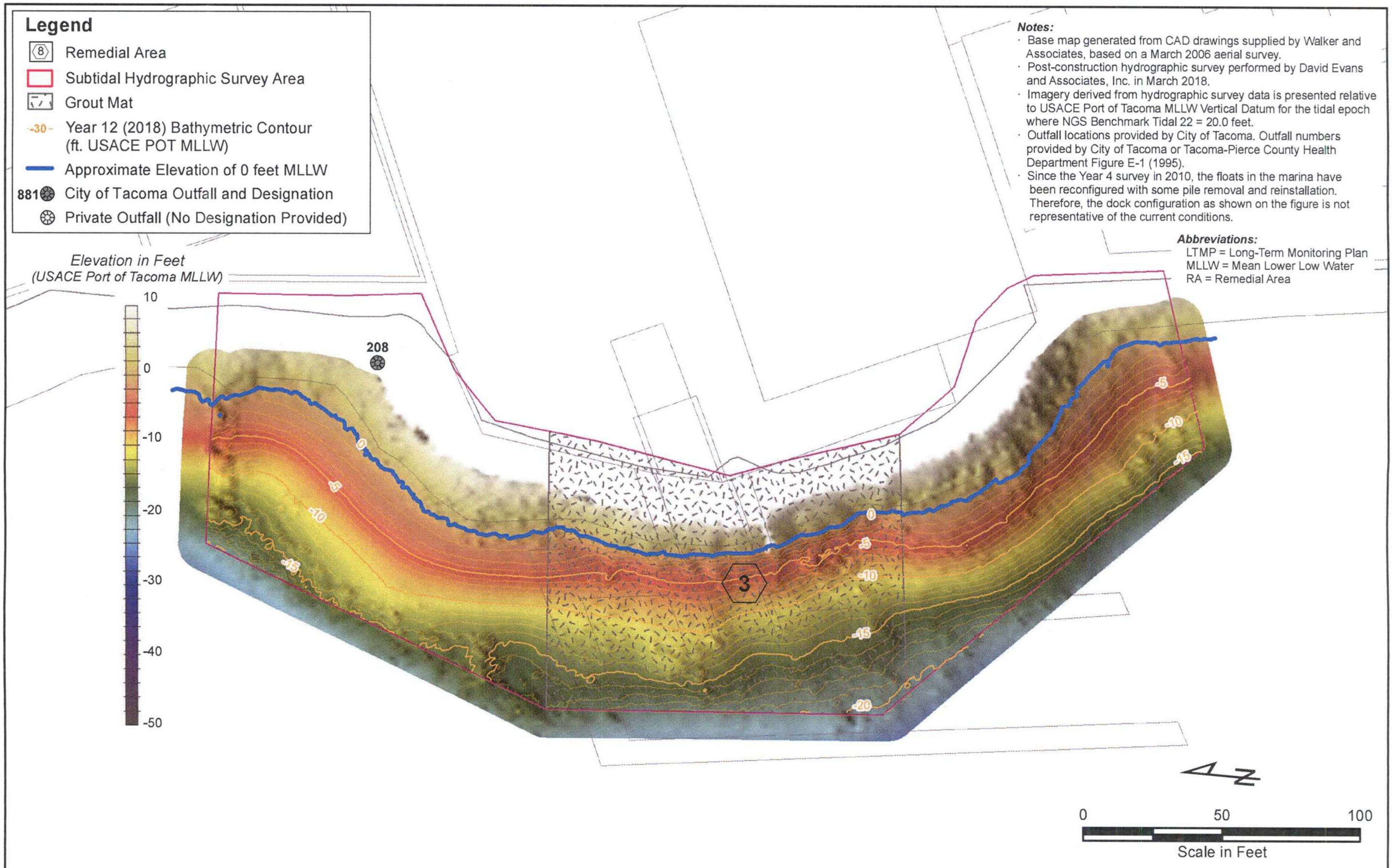

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Figure 9
RA 3 Year 12 (2018) Subtidal Hydrographic Survey Results

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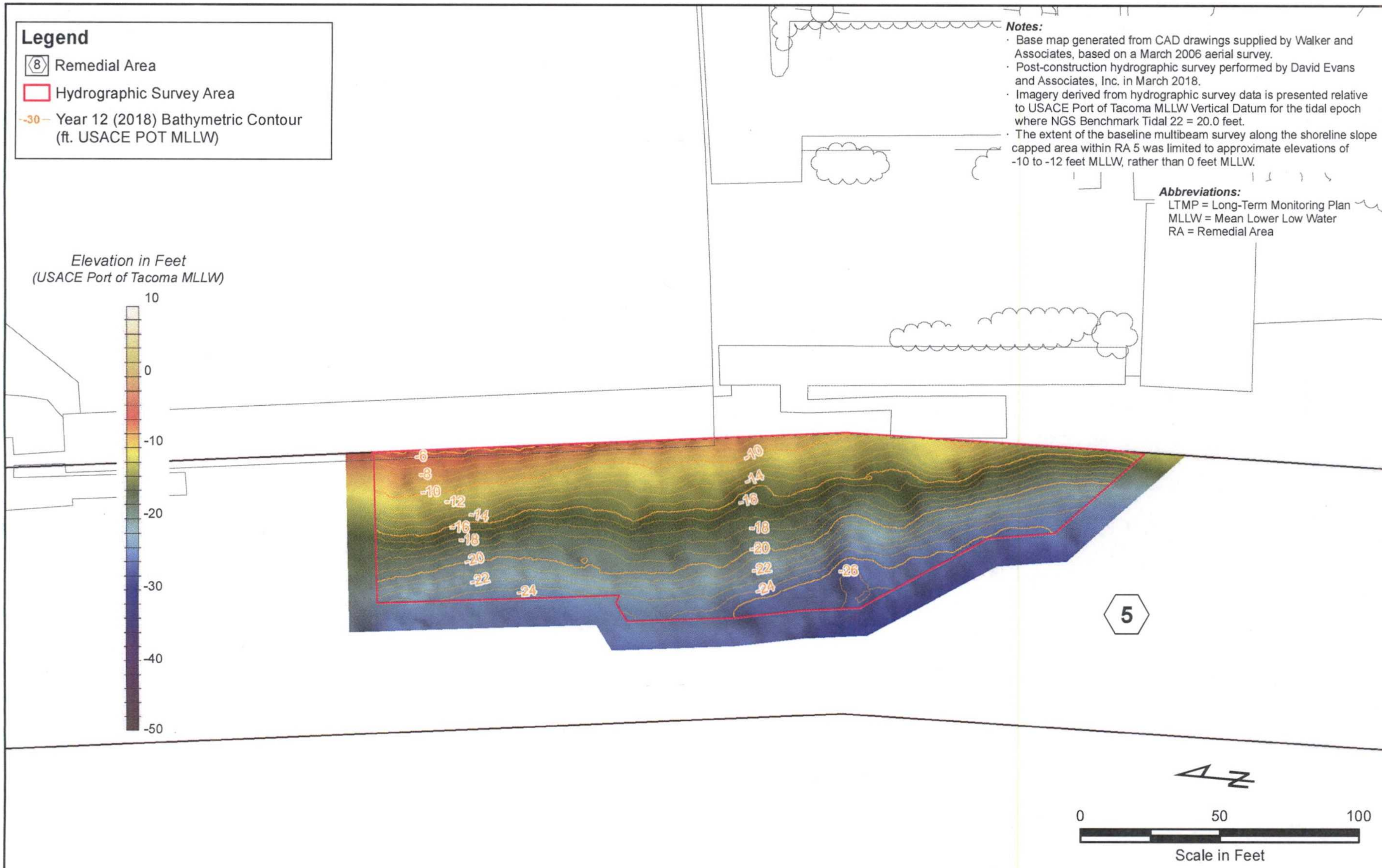

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Figure 10
RA 5 Year 12 (2018) Subtidal Hydrographic Survey Results

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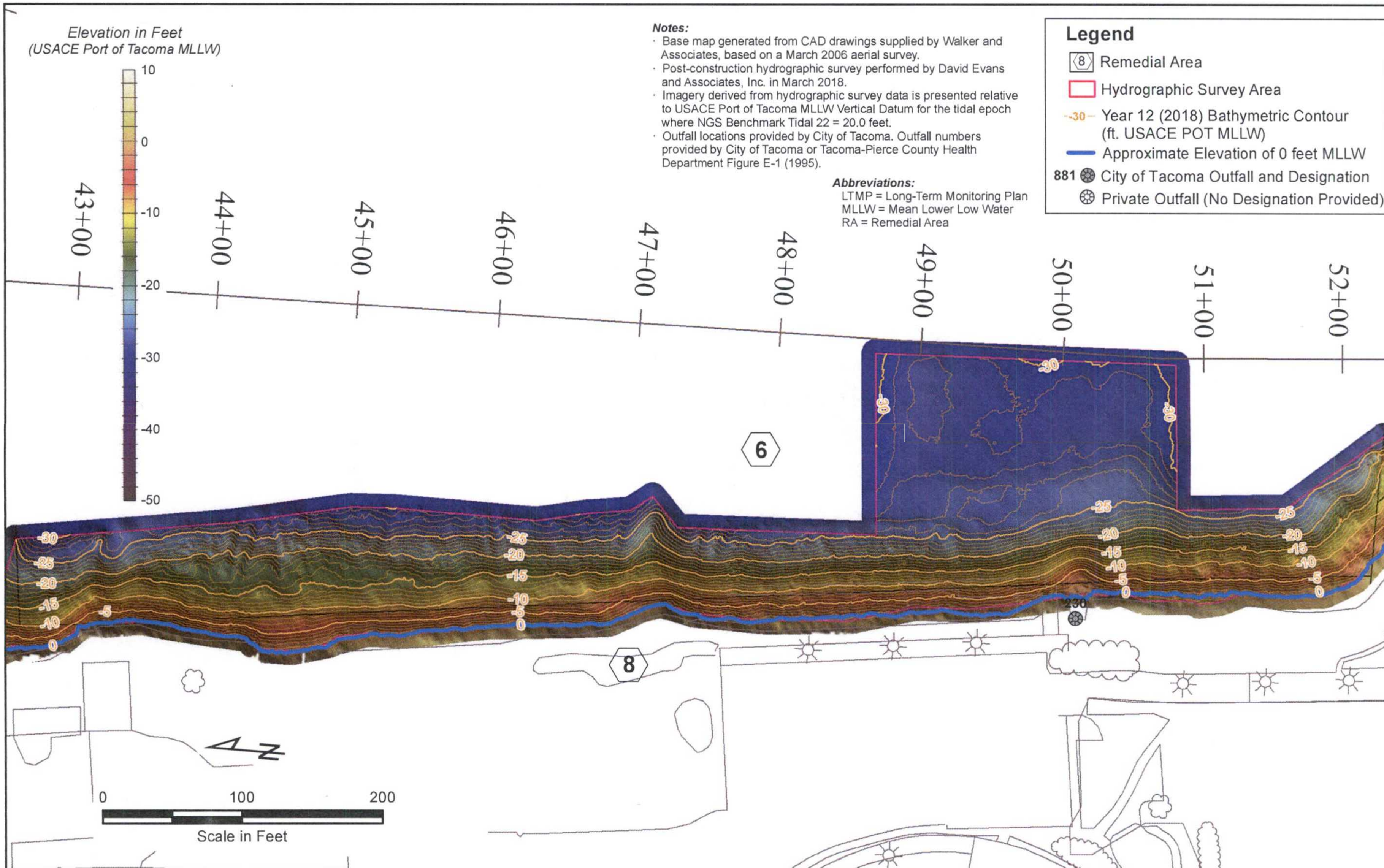

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Figure 11
RA 6 and Southern Portion of RA 8 Year 12 (2018) Subtidal Hydrographic Survey Results

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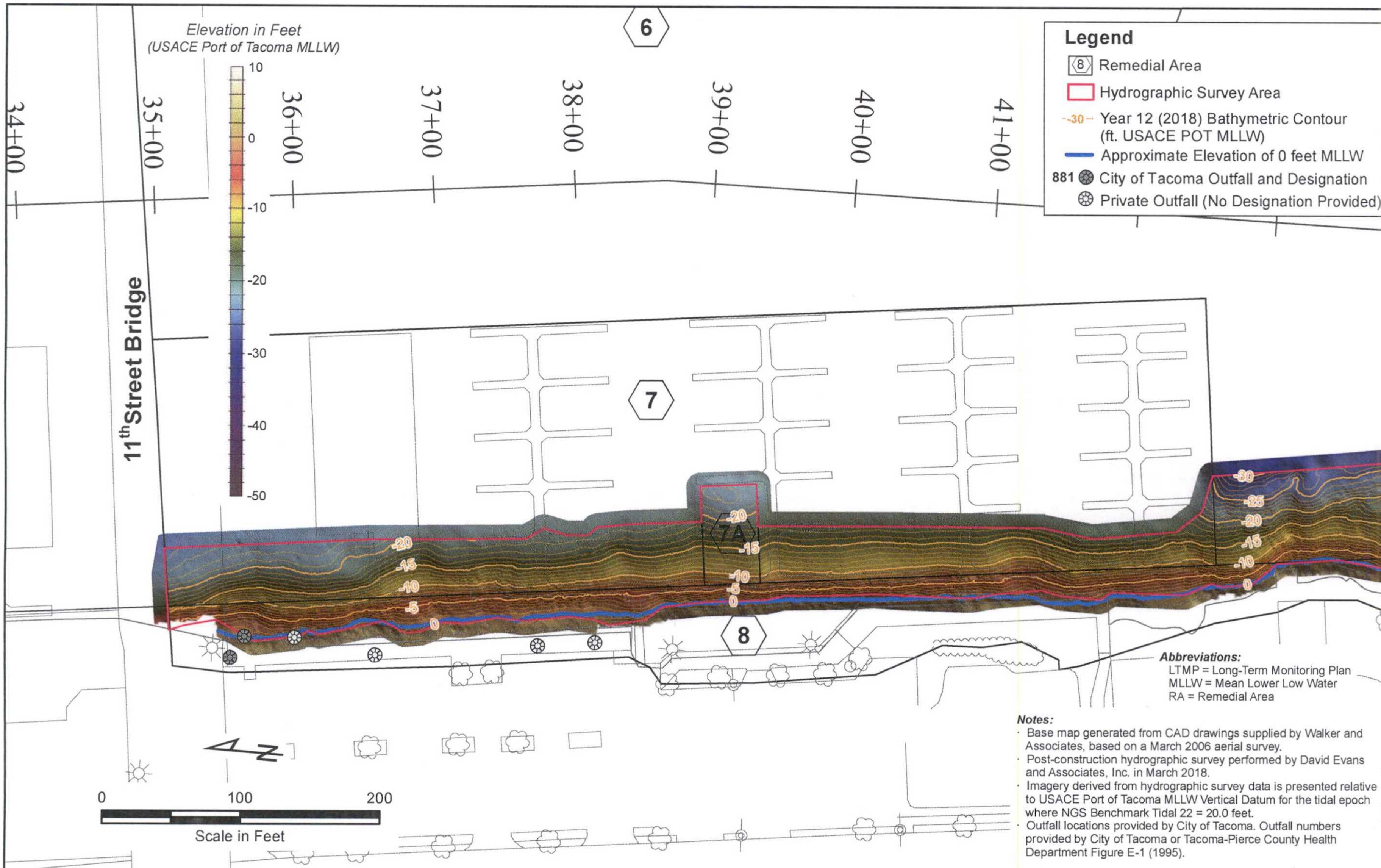

Notes:
- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic survey performed by David Evans and Associates, Inc. in March 2018.
- Imagery derived from hydrographic survey data is presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995).

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Figure 12
RA 7A and RA 8 Year 12 (2018) Subtidal Hydrographic Survey Results

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5/8/2018

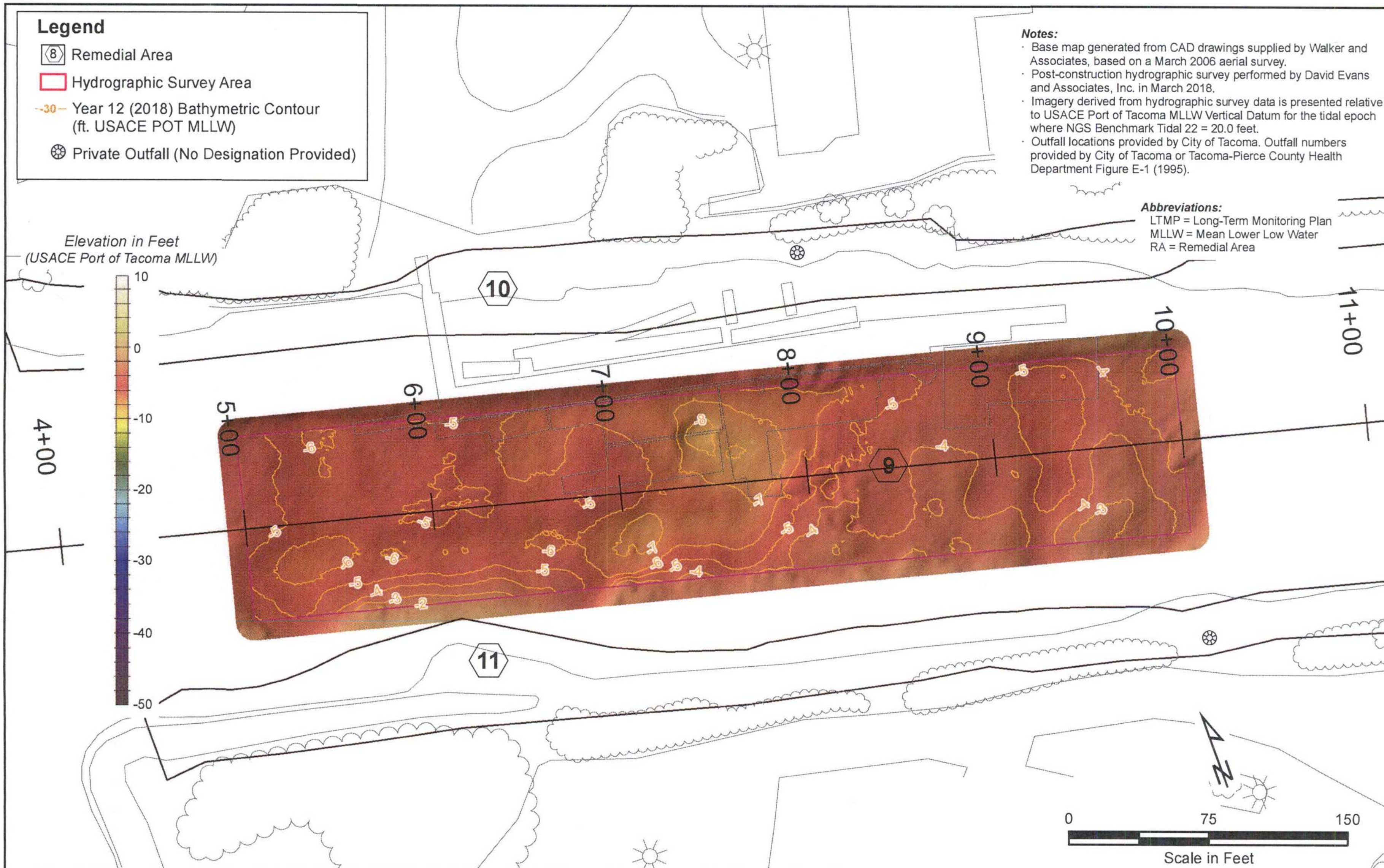

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Figure 13
RA 9 Year 12 (2018) Subtidal Hydrographic Survey Results

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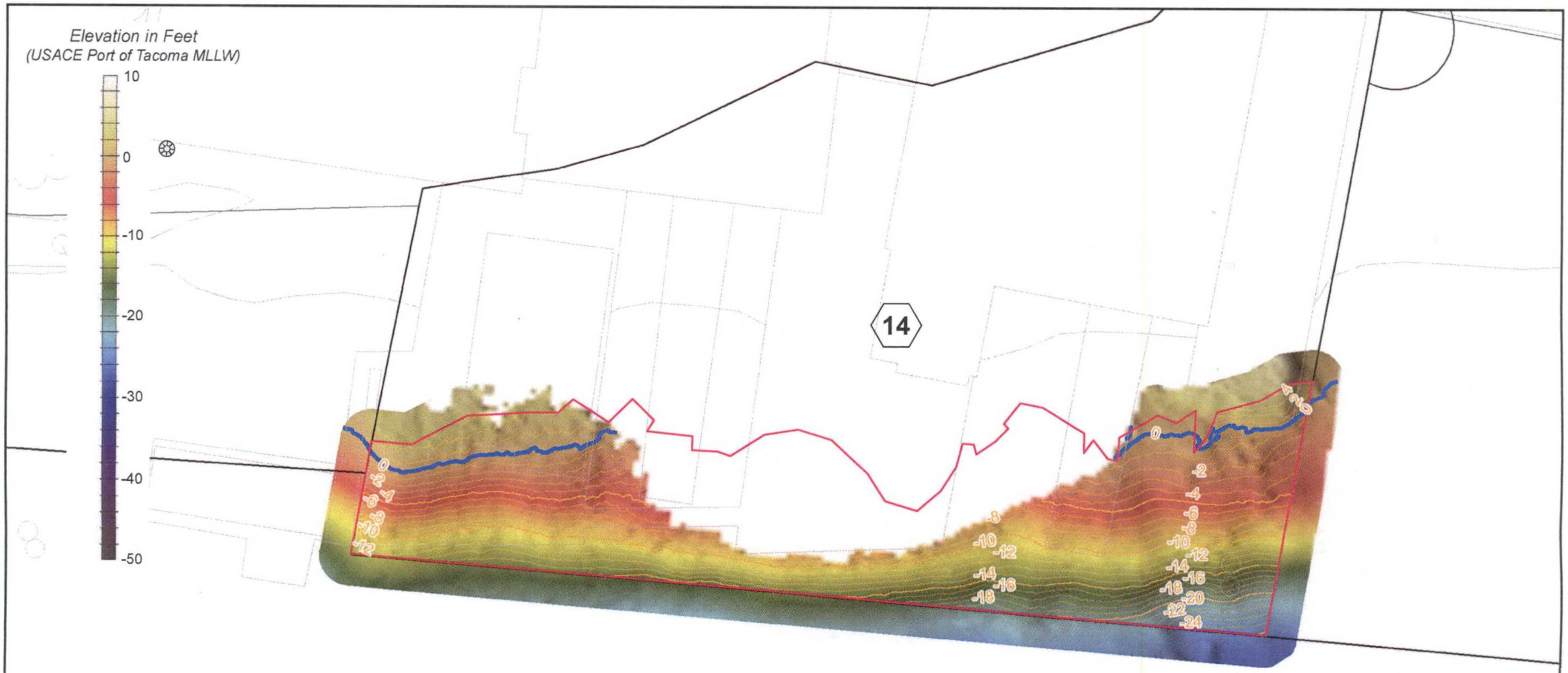

Legend

- Remedial Area
- Hydrographic Survey Area
- Year 12 (2018) Bathymetric Contour (ft. USACE POT MLLW)
- Approximate Elevation of 0 feet MLLW
- Private Outfall (No Designation Provided)

Notes:

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic survey performed by David Evans and Associates, Inc. in March 2018.
- Imagery derived from hydrographic survey data is presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995).

Abbreviations:

LTMP = Long-Term Monitoring Plan
MLLW = Mean Lower Low Water
RA = Remedial Area

0 50 100
Scale in Feet

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Figure 14
RA 14 Year 12 (2018) Subtidal Hydrographic Survey Results

I:\GIS\Projects\COT_ON_CALL\MXD\2018 Yr 12 Hydrographic Survey PFM\Figure 14 (RA 14 Year 12 (2018) Subtidal Hydrographic Survey Results).mxd
5/8/2018

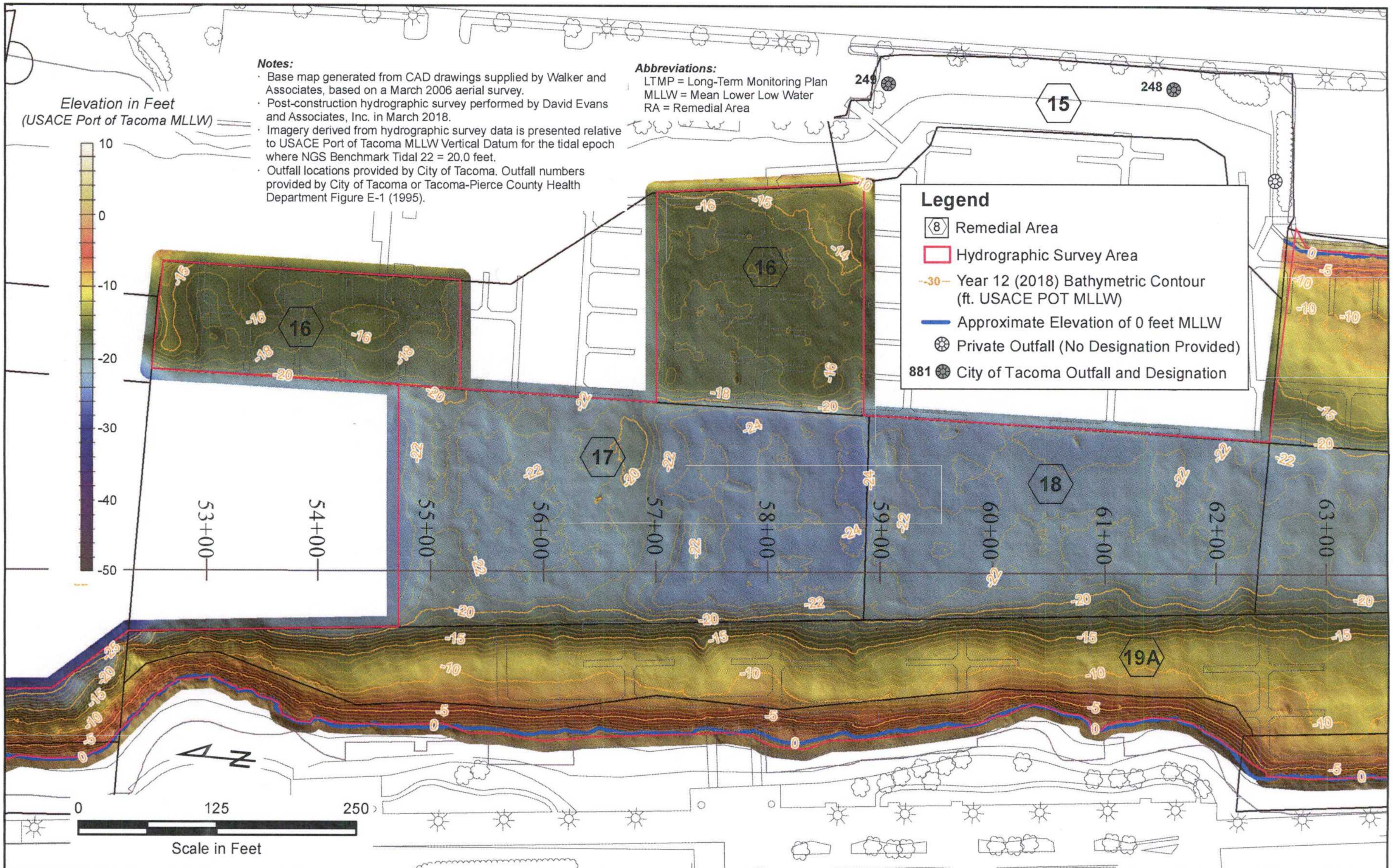

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Figure 15
RA 16, RA 17, RA 18, and RA 19A
Year 12 (2018) Subtidal Hydrographic Survey Results

I:\GIS\Projects\COT_ON_CALL\MXD\2018 Yr 12 Hydrographic Survey PFM\Figure 15 (RA 16 17 18 19A Year 12 (2018) Subtidal Hydrographic Survey Results).mxd
5/8/2018

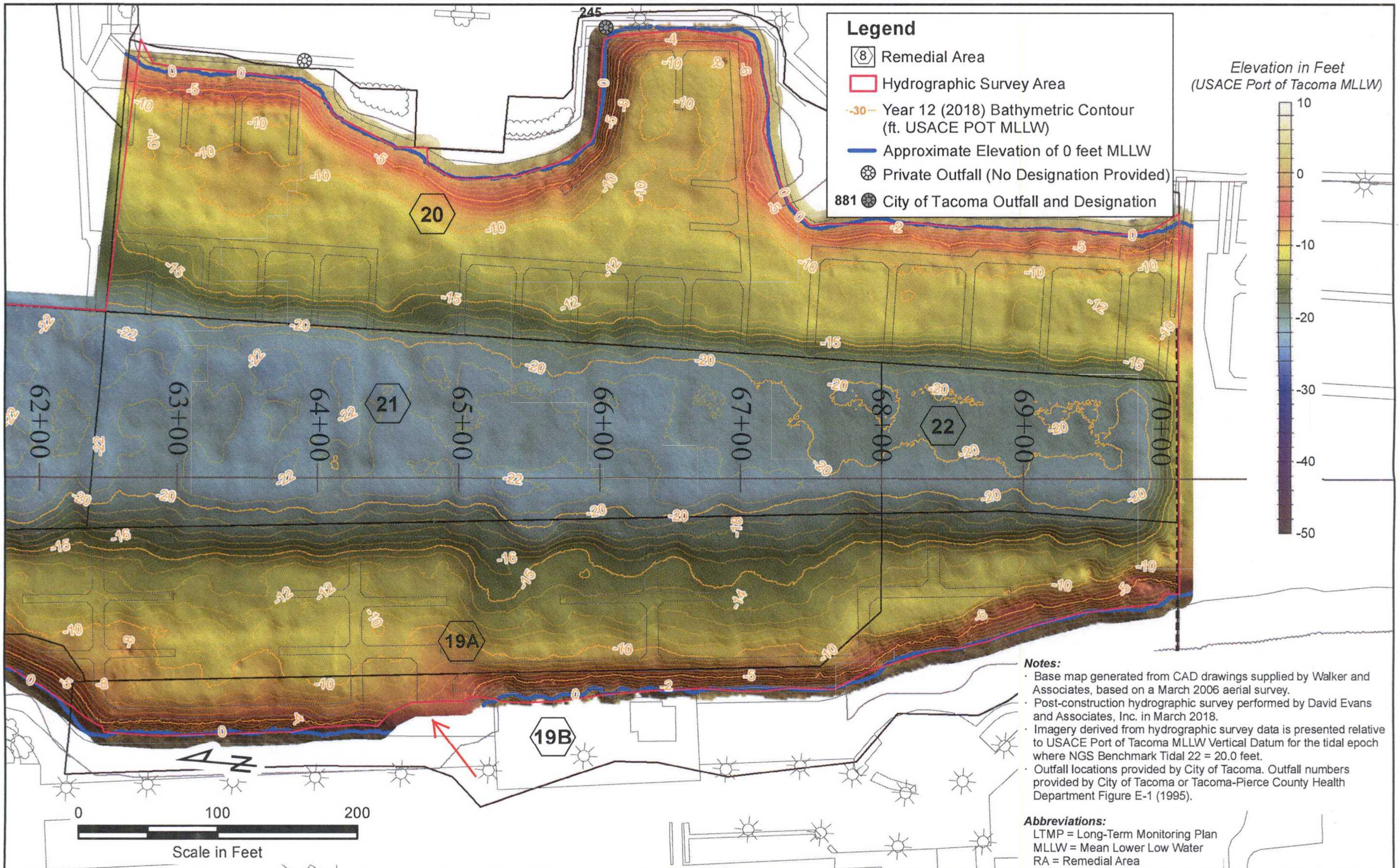

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Figure 16
RA 19A, RA 19B, RA 20, RA 21 and RA 22 Year 12 (2018) Subtidal Hydrographic Survey Results

I:\GIS\Projects\COT_ON_CALL\MXD\2018 Yr 12 Hydrographic Survey PFM\Figure 16 (RA 19 19B 20 21 22 Year 12 (2018 Subtidal Hydrographic Survey Results).mxd
5/8/2018

Notes:

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic survey performed by David Evans and Associates, Inc. in March 2018.
- Imagery derived from hydrographic survey data is presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- The MMB remedial action, that included placement of a sand cap, was completed in February 2015 and is located within an existing Natural Recovery area of the Thea Foss Waterway Superfund Site. Therefore, the area of the subtidal capped area is included in the LTMP hydrographic survey and analysis.

Abbreviations:

LTMP = Long-Term Monitoring Plan
MLLW = Mean Lower Low Water

Legend

Hydrographic Survey Area for Murray Morgan Bridge Remedial Action Area

-30 Year 3 (2018) Bathymetric Contour (ft. USACE POT MLLW)

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Figure 17
Murray Morgan Bridge Year 3 (2018) Subtidal Hydrographic Survey Results

I:\GIS\Projects\COT_ON_CALL\MXD\2018 Yr 12 Hydrographic Survey PFM\Figure 17 (Murray Morgan Bridge Year 3 (2018) Subtidal Hydrographic Survey Results).mxd
5/18/2018

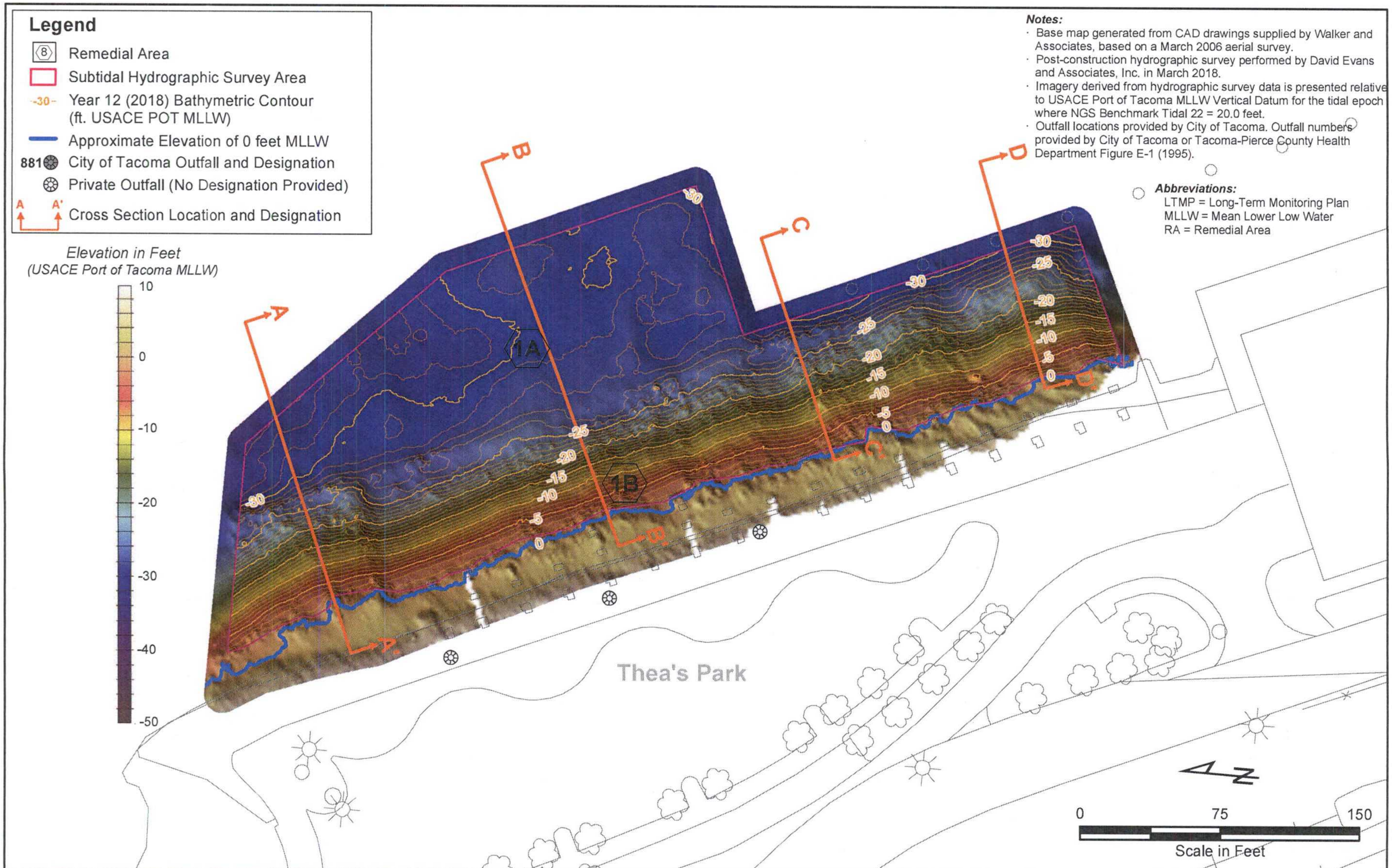

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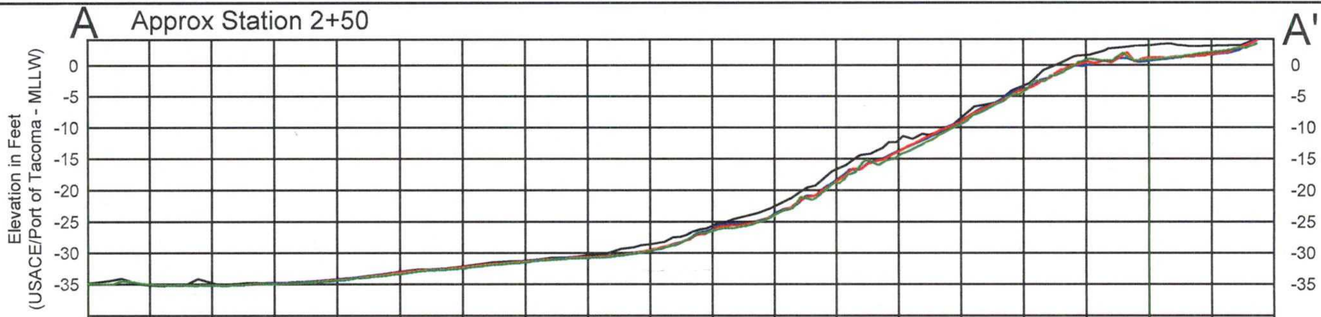
Figure 21
RA 1 Year 12 (2018) Locations of Bathymetric Cross Sections

I:\GIS\Projects\COT_ON_CALL\MXD\2018 Yr 12 Hydrographic Survey PFM\Figure 21 (RA 1 Year 12 (2018) Locations of Bathymetric Cross Sections).mxd
7/24/2018

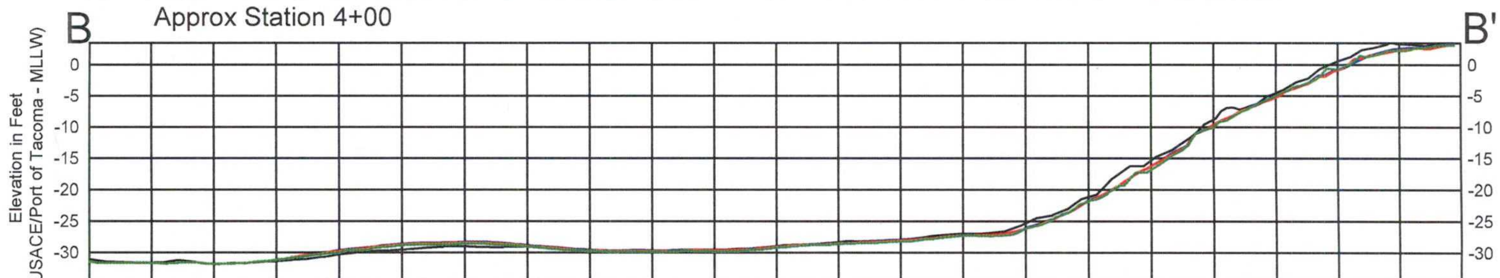
DWG NAME: E:\Project\clients\Floyd and Snider\2018\Thea Foss 2018\2018FSTheaFoss001.dwg
DATE: 7/24/2018 8:33 PM

A Approx Station 2+50 A'



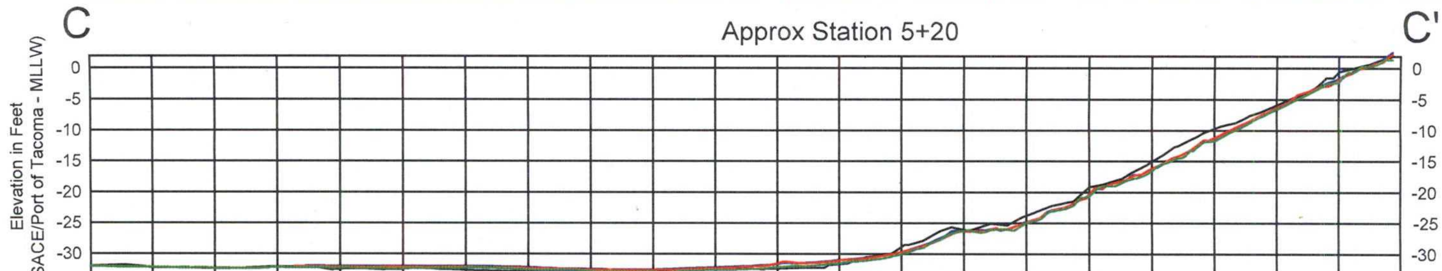
	0+10.00	0+20.00	0+30.00	0+40.00	0+50.00	0+60.00	0+70.00	0+80.00	0+90.00	1+00.00	1+10.00	1+20.00	1+30.00	1+40.00	1+50.00	1+60.00	1+70.00	1+80.00	1+90.00
Baseline (2003) SB	-35.2	-34.8	-34.9	-34.3	-33.2	-32.2	-31.4	-30.4	-28.6	-25.7	-22.6	-16.7	-12.0	-8.5	-3.3	1.5	3.1		
Year 2 (2008) MB			-35.0	-34.4	-33.4	-32.5	-31.5	-30.8	-29.7	-26.5	-24.0	-18.8	-14.6	-9.5	-4.3	0.8	0.9		
Year 10 (2016) MB			-34.8	-34.2	-33.1	-32.3	-31.3	-30.6	-29.6	-26.3	-23.8	-18.5	-13.8	-9.0	-3.8	-0.1	0.7		
Year 12 (2018) MB			-35.0	-34.3	-33.2	-32.3	-31.4	-30.7	-29.6	-26.5	-24.0	-18.6	-13.9	-9.2	-4.0	0.4	1.1		
Change in Elev (Baseline to Y12)			-0.1	0.0	0.0	-0.1	0.0	-0.3	-1.0	-0.8	-1.4	-1.9	-1.9	-0.7	-0.7	-1.1	-2.0		
Change in Elev (Y2 to Y12)			0.0	-0.1	-0.2	-0.2	-0.1	-0.1	-0.1	0.0	0.0	-0.2	-0.7	-0.3	-0.3	+0.4	-0.2		
Change in Elev (Y10 to Y12)			-0.2	-0.1	-0.1	0.0	-0.1	-0.1	0.0	-0.2	-0.2	-0.1	-0.1	-0.2	-0.2	+0.5	+0.4		

B Approx Station 4+00 B'



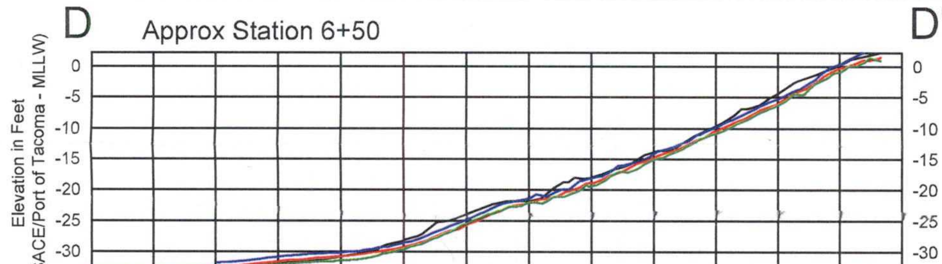
	0+10.00	0+20.00	0+30.00	0+40.00	0+50.00	0+60.00	0+70.00	0+80.00	0+90.00	1+00.00	1+10.00	1+20.00	1+30.00	1+40.00	1+50.00	1+60.00	1+70.00	1+80.00	1+90.00	2+00.00	2+10.00	2+20.00
Baseline (2003) SB	-31.7	-31.9	-31.4	-30.3	-29.6	-29.0	-29.1	-29.7	-29.8	-29.7	-29.1	-28.4	-28.1	-27.0	-25.4	-21.2	-15.4	-8.8	-4.5	0.5	3.3	
Year 2 (2008) MB				-30.0	-28.9	-28.6	-29.1	-29.8	-29.9	-29.8	-29.3	-28.7	-28.3	-27.4	-26.2	-21.9	-16.9	-10.0	-5.1	-0.8	2.2	
Year 10 (2016) MB				-29.7	-28.7	-28.4	-28.9	-29.6	-29.7	-29.6	-29.1	-28.5	-28.0	-27.2	-26.2	-21.8	-16.3	-9.8	-5.1	-0.9	2.5	
Year 12 (2018) MB				-29.8	-28.7	-28.5	-29.0	-29.7	-29.8	-29.7	-29.2	-28.6	-28.1	-27.3	-26.2	-21.9	-16.3	-9.7	-5.3	-0.9	2.3	
Change in Elev (Baseline to Y12)				+0.5	+0.9	+0.5	+0.1	0.0	0.0	0.0	-0.1	-0.2	0.0	-0.3	-0.8	-0.7	-0.9	-0.9	-0.8	-1.4	-1.0	
Change in Elev (Y2 to Y12)				-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1	0.0	0.0	-0.6	-0.3	+0.2	+0.1	-0.1	
Change in Elev (Y10 to Y12)				-0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	0.0	+0.1	-0.2	0.0	-0.2	

C Approx Station 5+20 C'



	0+10.00	0+20.00	0+30.00	0+40.00	0+50.00	0+60.00	0+70.00	0+80.00	0+90.00	1+00.00	1+10.00	1+20.00	1+30.00	1+40.00	1+50.00	1+60.00	1+70.00	1+80.00	1+90.00	2+00.00	2+10.00
Baseline (2003) SB	-32.2	-32.3	-32.1	-32.5	-32.4	-32.6	-32.8	-33.1	-33.0	-32.5	-32.3	-31.7	-28.9	-26.1	-23.8	-19.2	-15.1	-9.8	-5.9	-0.7	
Year 2 (2008) MB				-32.3	-32.3	-32.2	-32.5	-32.8	-32.9	-32.6	-32.2	-31.5	-30.1	-26.3	-25.0	-20.7	-16.6	-11.8	-6.6	-2.2	
Year 10 (2016) MB				-32.0	-32.0	-32.0	-32.2	-32.5	-32.6	-32.2	-31.7	-31.1	-29.7	-26.3	-24.9	-20.4	-16.3	-11.3	-6.4	-1.7	
Year 12 (2018) MB				-32.1	-32.1	-32.1	-32.3	-32.6	-32.6	-32.3	-31.6	-31.1	-29.7	-26.3	-25.0	-20.4	-16.3	-11.3	-6.4	-1.9	
Change in Elev (Baseline to Y12)				+0.4	+0.3	+0.5	+0.5	+0.5	+0.4	+0.2	+0.7	+0.6	-0.8	-0.2	-1.2	-1.2	-1.2	-1.5	-0.5	-1.2	
Change in Elev (Y2 to Y12)				-0.2	-0.2	-0.1	-0.2	-0.2	-0.3	-0.3	-0.6	-0.4	-0.4	0.0	0.0	-0.3	-0.3	-0.5	-0.2	-0.3	
Change in Elev (Y10 to Y12)				-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	+0.1	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-0.2	

D Approx Station 6+50 D'



	0+10.00	0+20.00	0+30.00	0+40.00	0+50.00	0+60.00	0+70.00	0+80.00	0+90.00	1+00.00	1+10.00	1+20.00	1+30.00
Baseline (2003) SB	-33.2	-32.8	-31.8	-30.9	-28.2	-24.0	-21.8	-18.1	-14.0	-9.7	-4.5	0.2	
Year 2 (2008) MB			-32.2	-31.5	-29.6	-25.6	-22.2	-19.5	-15.2	-10.9	-6.4	-1.0	
Year 10 (2016) MB			-31.6	-30.9	-29.4	-25.6	-22.2	-18.9	-15.0	-10.5	-6.1	-0.4	
Year 12 (2018) MB			-31.7	-30.9	-29.4	-25.8	-22.2	-19.0	-14.9	-10.5	-6.2	-0.4	
Change in Elev (Baseline to Y12)			+0.1	0.0	-1.2	-1.8	-0.4	-0.9	-0.9	-0.8	-1.7	-0.6	
Change in Elev (Y2 to Y12)			-0.5	-0.6	-0.2	+0.2	0.0	-0.5	-0.3	-0.4	-0.2	-0.6	
Change in Elev (Y10 to Y12)			-0.1	0.0	0.0	-0.2	0.0	-0.1	+0.1	0.0	-0.1	0.0	

NOTES:

1. Baseline (2003) Single Beam Survey performed by Parametrix. (Feb., 2003)
2. Year 2 (2008) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2008)
3. Year 10 (2016) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2016)
4. Year 12 (2018) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2018)
5. Contours and imagery derived from bathymetric data are presented in units of feet relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
6. Elevation changes greater than 6 inches are shaded in gray.

0 30 60
Scale in Feet

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LTMP

Figure 22
RA 1 Comparison of Yr 12 to Baseline, Yr 2 and Yr 10 Subtidal Capped Areas Cross Sections

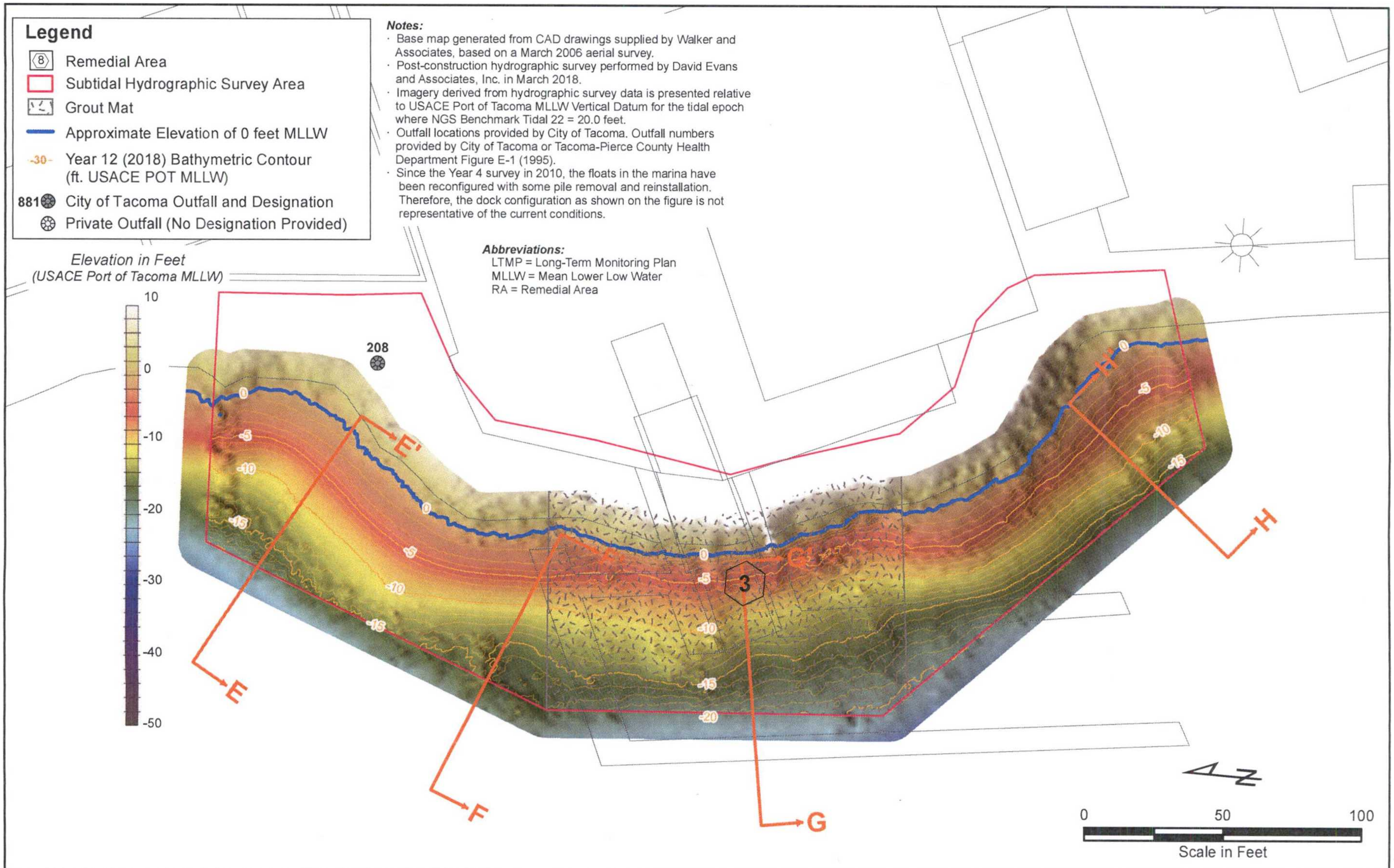

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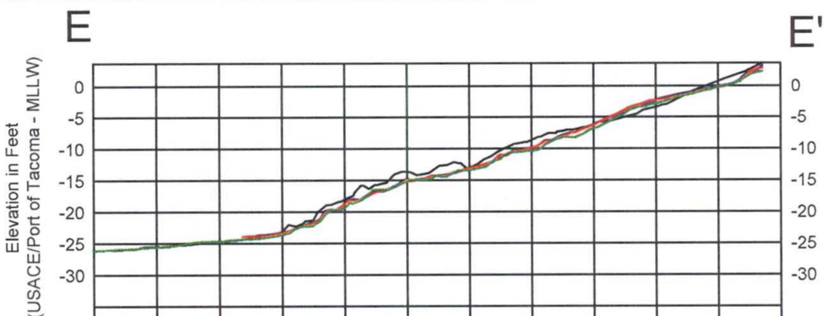
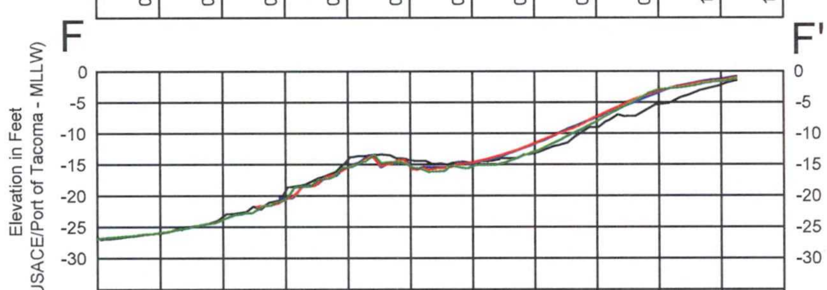
Figure 23
RA 3 Year 12 (2018) Locations of Bathymetric Cross Sections

I:\GIS\Projects\COT_ON_CALL\MXD\2018 Yr 12 Hydrographic Survey PFM\Figure 23 (RA 3 Year 12 (2018) Locations of Bathymetric Cross Sections).mxd
7/24/2018

DWG NAME: E:\Project\clients\Floyd and Snider\2018\Thea Foss 2018\2018FSTheaFoss001.dwg
DATE: 7/24/2018 8:34 PM

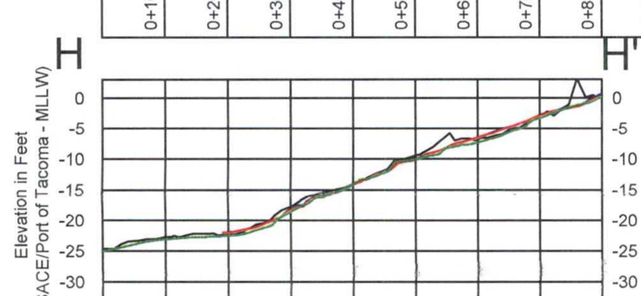


	0+10.00	0+20.00	0+30.00	0+40.00	0+50.00	0+60.00	0+70.00	0+80.00	0+90.00	1+00.00	1+10.00
Baseline (2003) SB	-25.5	-24.8	-23.2	-18.0	-13.7	-13.1	-8.7	-6.3	-3.4	0.7	
Year 2 (2008) MB			-23.7	-19.3	-15.2	-13.4	-10.4	-6.8	-2.8	-0.2	
Year-10 (2016) MB			-23.3	-18.7	-14.8	-13.1	-9.9	-6.2	-2.4	-0.2	
Year 12 (2018) MB			-23.4	-18.8	-14.9	-13.1	-9.9	-6.3	-2.3	-0.3	
Change in Elev (Baseline to Y12)			-0.2	-0.8	-1.2	0.0	-1.2	0.0	+1.1	-1.0	
Change in Elev (Y2 to Y12)			-0.3	-0.5	-0.3	-0.3	-0.5	-0.5	-0.5	+0.1	
Change in Elev (Y10 to Y12)			-0.1	-0.1	-0.1	0.0	0.0	-0.1	+0.1	-0.1	



	0+10.00	0+20.00	0+30.00	0+40.00	0+50.00	0+60.00	0+70.00	0+80.00	0+90.00	1+00.00
Baseline (2003) SB	-26.0	-23.4	-19.3	-14.3	-14.3	-14.9	-13.2	-9.0	-5.4	-2.2
Year 2 (2008) MB			-20.6	-15.5	-15.3	-15.3	-13.0	-8.1	-3.1	-1.6
Year-10 (2016) MB			-20.4	-15.5	-15.2	-14.8	-11.8	-7.5	-3.5	-1.3
Year 12 (2018) MB			-20.6	-15.5	-15.4	-14.7	-11.7	-7.4	-3.3	-1.5
Change in Elev (Baseline to Y12)			-1.3	-1.2	-1.1	+0.2	+1.5	+1.6	+2.1	+0.7
Change in Elev (Y2 to Y12)			0.0	0.0	+0.1	-0.6	-1.3	-0.7	+0.2	-0.1
Change in Elev (Y10 to Y12)			-0.2	0.0	-0.2	+0.1	+0.1	+0.1	+0.2	-0.2

	0+10.00	0+20.00	0+30.00	0+40.00	0+50.00	0+60.00	0+70.00	0+80.00	0+90.00	1+00.00
Baseline (2003) SB	-26.3	-25.3	-22.8	-19.1	-16.4	-15.6	-13.0	-9.0	-4.1	
Year 2 (2008) MB			-23.4	-19.8	-16.9	-15.7	-13.0	-9.0	-4.4	
Year-10 (2016) MB			-23.0	-19.7	-16.7	-15.1	-12.3	-8.5	-4.1	
Year 12 (2018) MB			-23.0	-19.8	-16.8	-15.0	-12.3	-8.6	-4.3	
Change in Elev (Baseline to Y12)			-0.2	-0.7	-0.4	+0.6	+0.7	+0.4	-0.2	
Change in Elev (Y2 to Y12)			-0.4	0.0	-0.1	-0.7	-0.7	-0.4	-0.1	
Change in Elev (Y10 to Y12)			0.0	-0.1	-0.1	+0.1	0.0	-0.1	-0.2	



	0+10.00	0+20.00	0+30.00	0+40.00	0+50.00	0+60.00	0+70.00	0+80.00
Baseline (2003) SB	-22.8	-22.3	-17.8	-14.1	-9.5	-6.9	-3.3	
Year 2 (2008) MB			-18.7	-14.2	-10.2	-7.4	-3.2	
Year-10 (2016) MB			-18.2	-14.1	-10.1	-6.6	-2.9	
Year 12 (2018) MB			-18.4	-14.2	-10.2	-6.6	-2.9	
Change in Elev (Baseline to Y12)			-0.6	-0.1	-0.7	+0.3	+0.4	
Change in Elev (Y2 to Y12)			-0.3	0.0	0.0	-0.8	-0.3	
Change in Elev (Y10 to Y12)			-0.2	-0.1	-0.1	0.0	0.0	

NOTES:

1. Baseline (2003) Single Beam Survey performed by Parametrix. (Feb., 2003)
2. Year 10 (2016) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2016)
3. Year 12 (2018) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2018)
4. Contours and imagery derived from bathymetric data are presented in units of feet relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
5. Elevation changes greater than 6 inches are shaded in gray.

0 30 60
Scale in Feet

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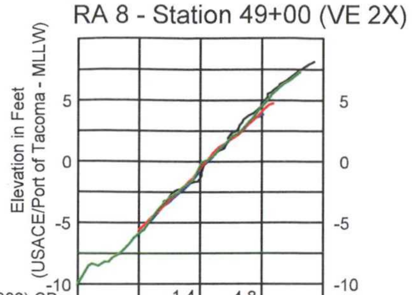
Figure 24
RA 3 Comparison of Yr 12 to Baseline, Yr 2 and Yr 10 Subtidal Capped Areas Cross Sections

I I'

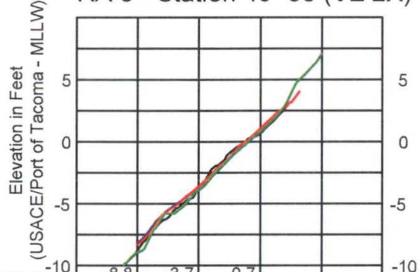
RA 8 - Station 49+00 (VE 2X)



	8+90	9+00	9+10
Baseline (2003) SB		-1.4	4.8
Year 2 (2008) MB		-0.4	4.5
Year-10 (2016) MB		-0.7	3.8
Year-12 (2018) MB		-0.5	4.1
Change in Elev (Baseline to Y12)		+0.9	-0.7
Change in Elev (Y2 to Y12)		+0.1	-0.4
Change in Elev (Y10 to Y12)		+0.2	+0.3

J J'

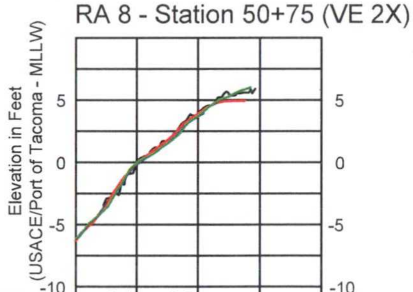
RA 8 - Station 49+50 (VE 2X)



	8+80	8+90	9+00	9+10
Baseline (2003) SB	-8.8	-3.7	0.7	
Year 2 (2008) MB	-8.9	-3.9	0.8	
Year-10 (2016) MB	-8.2	-3.6	1.0	
Year-12 (2018) MB	-8.3	-3.6	1.0	
Change in Elev (Baseline to Y12)	+0.5	+0.1	+0.3	
Change in Elev (Y2 to Y12)	+0.6	+0.3	+0.2	
Change in Elev (Y10 to Y12)	-0.1	0.0	0.0	

K K'

RA 8 - Station 50+75 (VE 2X)



	8+80	8+90
Baseline (2003) SB	-0.1	3.8
Year 2 (2008) MB	0.0	3.7
Year-10 (2016) MB	-0.1	3.7
Year-12 (2018) MB	-0.1	3.9
Change in Elev (Baseline to Y12)	0.0	+0.1
Change in Elev (Y2 to Y12)	-0.1	+0.2
Change in Elev (Y10 to Y12)	0.0	+0.2

NOTES:

1. Baseline single beam transects performed by Manson following construction completion (2005/2006).
2. Year 2 (2008) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2008)
3. Year 10 (2016) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2016)
4. Year 12 (2018) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2018)
5. Contours and imagery derived from bathymetric data are presented in units of feet relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
6. VE - vertical exaggeration of profile.
7. Elevation changes greater than 6 inches are shaded in gray.

Horizontal Scale in Feet
0 30 60

0 15 30
Vertical Exaggeration Scale in Feet

DWG NAME: E:\Project\clients\Floyd and Snider\2018\Thea Foss 2018\2018FSTheaFoss002.dwg
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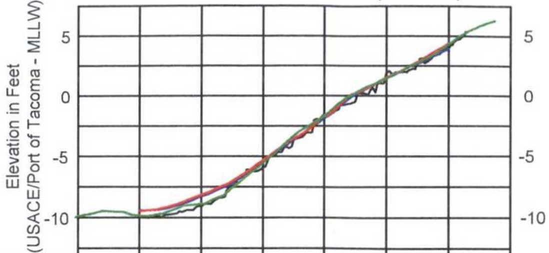
Figure 25
RA 8 Comparison of Yr 12 to Baseline, Yr 2 and Yr 10 Subtidal Capped Area Cross Sections

L RA 19A - Station 56+00 (VE 2X) L'

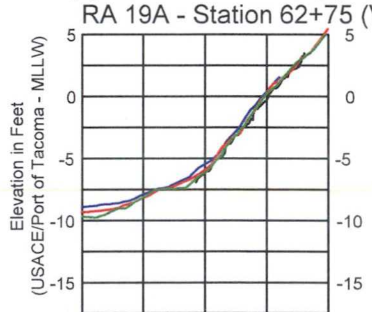


	8+20	8+30	8+40	8+50	8+60	8+70
Baseline (2003) SB		-9.1	-5.9	-1.6	1.8	4.1
Year 2 (2008) MB		-8.9	-5.5	-1.6	1.5	
Year-10 (2016) MB		-8.3	-5.3	-1.8	1.5	
Year-12 (2018) MB		-8.1	-5.3	-1.7	1.5	
Change in Elev (Baseline to Y12)		+1.0	+0.6	-0.1	-0.3	
Change in Elev (Y2 to Y12)		+0.8	+0.2	-0.1	0.0	
Change in Elev (Y10 to Y12)		+0.2	0.0	+0.1	0.0	

M RA 19A - Station 57+00 (VE 2X) M'

	8+20	8+30	8+40	8+50	8+60	8+70
Baseline (2003) SB	-10	-7.9	-5.9	-1.0	2.8	3.5
Year 2 (2008) MB	-9.5	-8.2	-5.8	-1.5	1.7	
Year-10 (2016) MB	-9.7	-8.8	-5.9	-2.1	1.7	
Year-12 (2018) MB	-9.6	-8.6	-5.8	-2.1	1.8	
Change in Elev (Baseline to Y12)	+0.4	-0.7	+0.1	-1.1	-1.0	
Change in Elev (Y2 to Y12)	-0.1	-0.4	0.0	-0.6	+0.1	
Change in Elev (Y10 to Y12)	+0.1	+0.2	+0.1	0.0	+0.1	

N RA 19A - Station 62+75 (VE 2X) N'



	8+70	8+80	8+90	9+00
Baseline (2003) SB		-6.0	-0.3	
Year 2 (2008) MB		-6.1		
Year-10 (2016) MB		-5.5		
Year-12 (2018) MB		-5.9		
Change in Elev (Baseline to Y12)		+0.1		
Change in Elev (Y2 to Y12)		+0.2		
Change in Elev (Y10 to Y12)		-0.4		

NOTES:

1. Baseline single beam transects performed by Manson following construction completion (2005/2006).
2. Year 2 (2008) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2008)
3. Year 10 (2016) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2016)
4. Year 12 (2018) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2018)
5. Contours and imagery derived from bathymetric data are presented in units of feet relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
6. VE - vertical exaggeration of profile.
7. Elevation changes greater than 6 inches are shaded in gray.

Horizontal Scale in Feet
0 30 60

0 15 30
Vertical Exaggeration Scale in Feet

DWG NAME: E:\Project\clients\Floyd and Snider\2018\Thea Foss 2018\2018FSTheaFoss002.dwg
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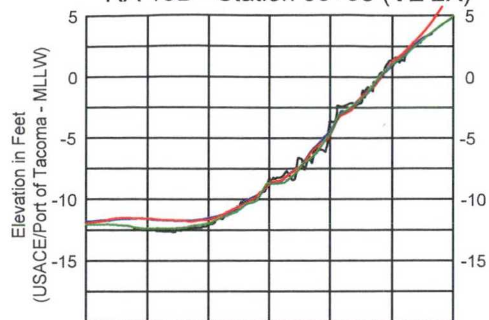
Figure 26
RA 19A Comparison of Yr 12 to Baseline, Yr 2 and Yr 10 Subtidal Capped Area Cross Sections

O — O'

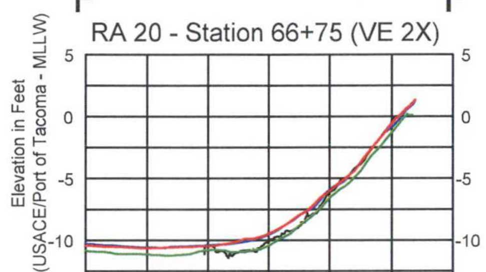
RA 19B - Station 68+50 (VE 2X)



Baseline (2003) SB	-12.5	-12.1	-8.3	-3.6	1.2	
Year 2 (2008) MB	-12.3	-11.9	-8.7	-4.6	1.0	
Year-10 (2016) MB	-11.6	-11.5	-8.8	-4.4	1.0	
Year-12 (2018) MB	-11.6	-11.6	-8.7	-4.7	1.2	
Change in Elev (Baseline to Y12)	+0.9	+0.5	-0.4	-1.1	0.0	
Change in Elev (Y2 to Y12)	+0.9	+0.3	0.0	-0.1	+0.2	
Change in Elev (Y10 to Y12)	0.0	-0.1	+0.1	-0.3	+0.2	
	7+90	8+00	8+10	8+20	8+30	8+40

P — P'

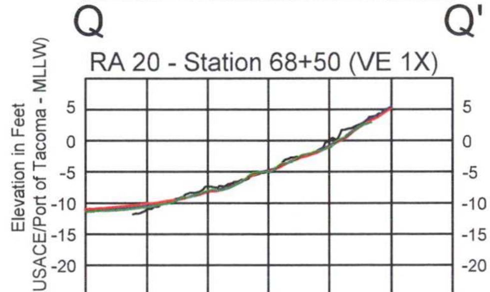
RA 20 - Station 66+75 (VE 2X)



Baseline (2003) SB			-10.4	-10.2	-6.1	-0.5
Year 2 (2008) MB			-10.8	-10.4	-6.5	-1.2
Year-10 (2016) MB			-10.4	-9.5	-5.9	-0.9
Year-12 (2018) MB			-10.5	-9.5	-6.0	-0.6
Change in Elev (Baseline to Y12)			-0.3	+0.9	+0.1	-0.1
Change in Elev (Y2 to Y12)			+0.3	+0.9	+0.5	+0.6
Change in Elev (Y10 to Y12)			-0.1	0.0	-0.1	+0.3
		4+30	4+20	4+10	4+00	3+90

Q — Q'

RA 20 - Station 68+50 (VE 1X)



Baseline (2003) SB		-11.0	-7.4	-4.8	0.1	
Year 2 (2008) MB		-10.6	-8.0	-5.0	-1.0	
Year-10 (2016) MB		-10.3	-8.1	-4.7	-0.8	
Year-12 (2018) MB		-10.0	-8.2	-4.9	-1.0	
Change in Elev (Baseline to Y12)		+1.0	-0.8	-0.1	-1.1	
Change in Elev (Y2 to Y12)		+0.6	-0.2	+0.1	0.0	
Change in Elev (Y10 to Y12)		+0.3	-0.1	-0.2	-0.2	
	5+70	5+60	5+50	5+40	5+30	5+20

NOTES:

1. Baseline single beam transects performed by Manson following construction completion (2005/2006).
2. Year 2 (2008) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2008)
3. Year 10 (2016) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2016)
4. Year 12 (2018) Multibeam Survey performed by David Evans and Associates, Inc. (March, 2018)
5. Contours and imagery derived from bathymetric data are presented in units of feet relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
6. VE - vertical exaggeration of profile.
7. Elevation changes greater than 6 inches are shaded in gray.

Horizontal Scale in Feet
0 30 60

0 15 30
Vertical Exaggeration Scale in Feet

DWG NAME: E:\Project\clients\Floyd and Snider\2018\Thea Foss 2018\2018FSTheaFoss002.dwg
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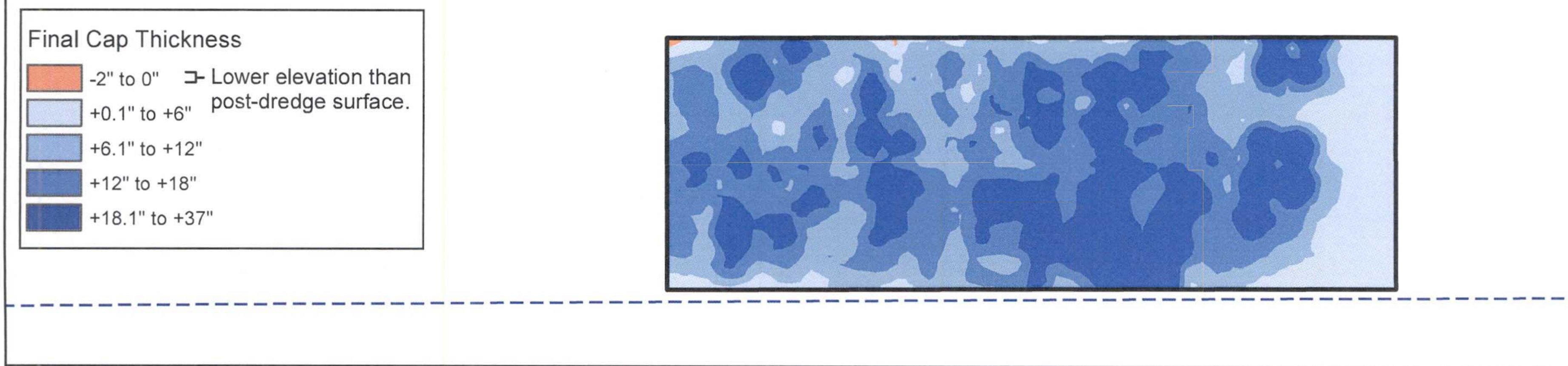
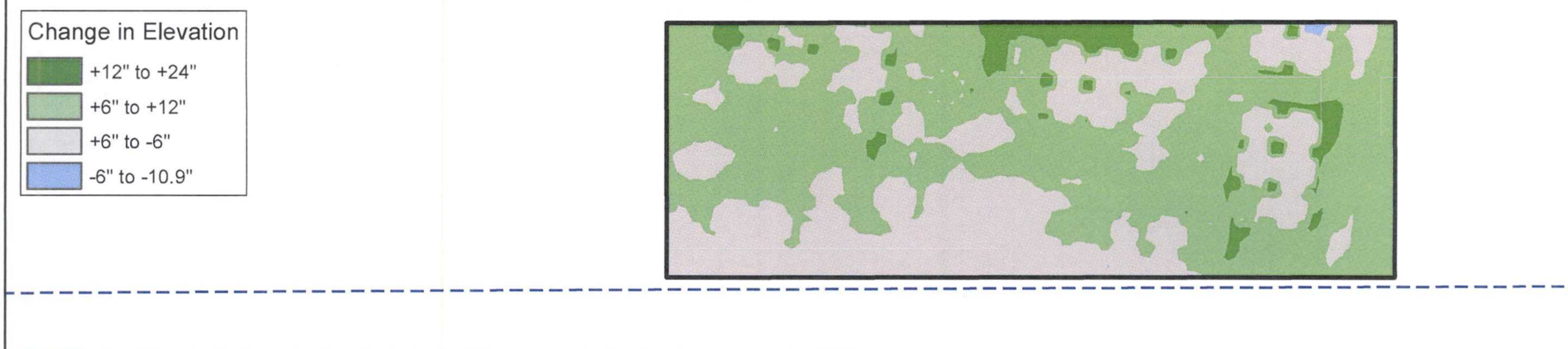
Figure 27
RA 19B & 20 Comparison of Yr 12 to Baseline, Yr 2 and Yr 10 Subtidal Capped Area Cross Sections

Final Post Construction Cap Thickness 2015



Comparison of Cap Surface Elevation Between 2015 and 2016



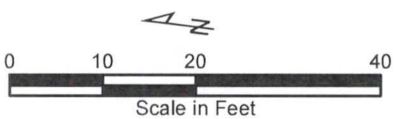
Legend

Remedial Action Area Extent

Navigation Channel

Abbreviations:

LTMP = Long-Term Monitoring Plan



Notes:

- The 2015 image displays the post-remedial action hydrographic survey and lead line soundings subtracted from the post-dredge hydrographic survey and lead line soundings, and displayed using bilinear interpolation. The result is the final cap thickness within the remedial action area.
- The 2016 hydrographic survey was completed by David Evans and Associates. The 2016 survey data was compared to the 2015 survey to provide a change in surface elevation image. Surface elevation is evaluated relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.

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Figure 28
Murray Morgan Bridge Comparison of 2015 and 2016 Subtidal Hydrographic Survey Results

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7/24/2018

Notes:
- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic survey performed by David Evans and Associates, Inc. in March 2018.
- Imagery derived from hydrographic survey data is presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- The MMB remedial action, that included placement of a sand cap, was completed in February 2015 and is located within an existing Natural Recovery area of the Thea Foss Waterway Superfund Site. Therefore, the area of the subtidal capped area is included in the LTMP hydrographic survey and analysis.

Abbreviations:
LTMP = Long-Term Monitoring Plan

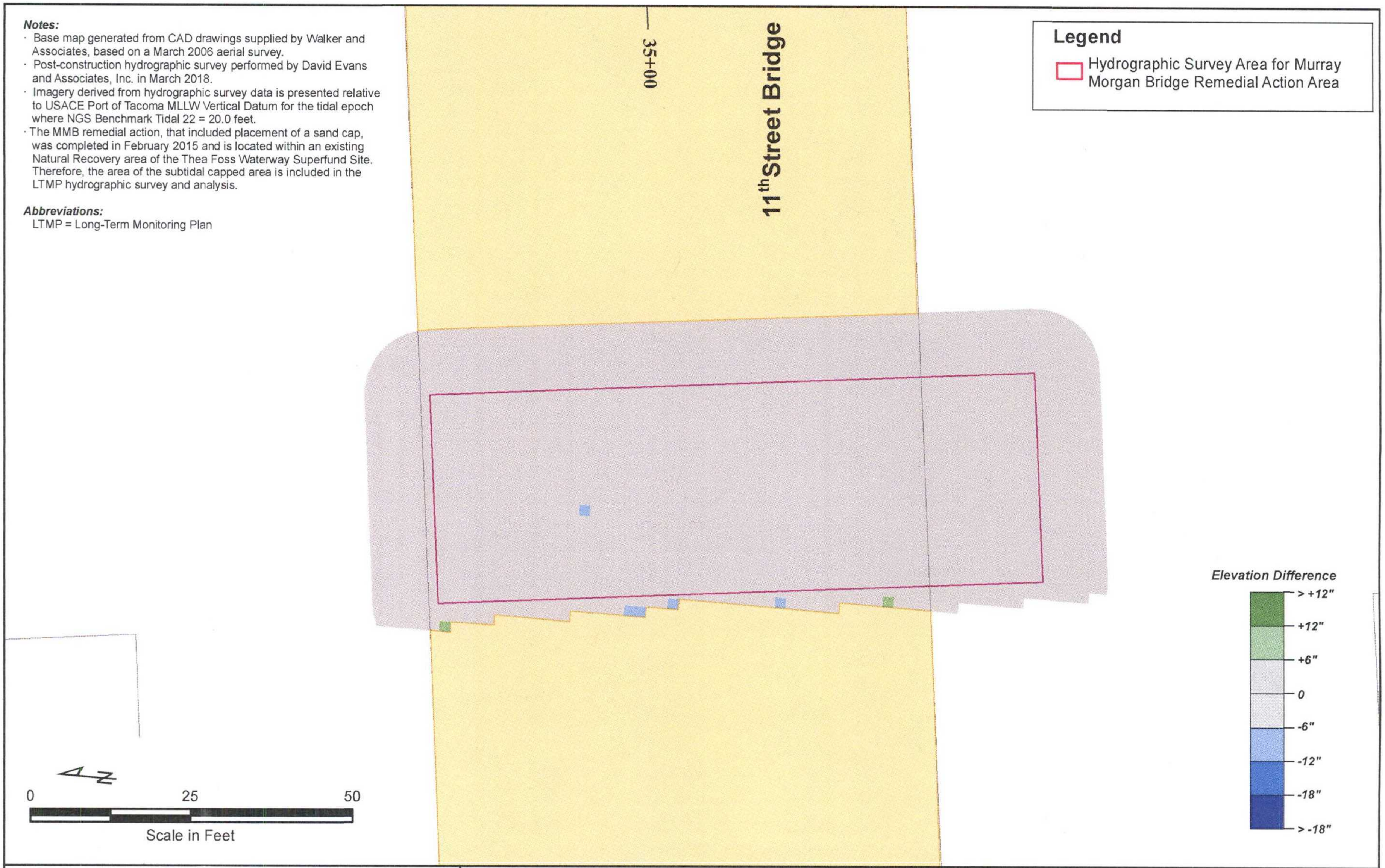

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Figure 29
Murray Morgan Bridge Comparison of Baseline (2016) to Year 3 (2018) Subtidal Hydrographic Survey Results

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7/24/2018

ATTACHMENT A

YEAR 12 (2018) SURVEY EQUIPMENT AND PROCEDURES

DAVID EVANS AND ASSOCIATES INC.
MARINE SERVICES

MEMORANDUM

Date: April 27, 2018
Client: City of Tacoma represented by Floyd | Snider
Subject: Thea Foss and Wheeler Osgood Waterways Remediation Project
Year 12 (2018) Subtidal Cap Monitoring Hydrographic Survey
Summary of Survey Procedures and Equipment

Project Parameters
Horizontal Datum: *North American Datum of 1983 with the 1991 adjustment (NAD 83/91)*

Vertical Datum: *Project Datum (NOS Tidal 22 = 20.0'), which holds an elevation of 20.00 feet on National Ocean Service (NOS) Bench Mark "Tidal 22"*
Coordinate System: *Washington State Plane – South Zone*
Units: *US Survey Feet*

Survey Dates
March 28, 2018 and March 29, 2018

Survey Crew
John Staly – Senior Hydrographer
Jason Dorfman – Hydrographer III
Nick Lesnikowski – Project Manager, NSPS/THSOA* Hydrographer
Greg Baird – Project Surveyor, Professional Land Surveyor WA & OR, NSPS/THSOA* Hydrographer
Client representative Lynn Grochala for Floyd-Snider was on board during survey operations.

Equipment
Vessel – DEA's 19-foot custom survey vessel *River Hawk*
Multibeam – Reson SeaBat 7101, 240 kHz, 511 beams, 140° swath
Motion Sensor – Applanix POS-MV version 5
Heading Sensor – Applanix POS-MV version 5
Vessel Positioning – Applanix POS-MV and Trimble SPS-855 RTK-GNSS rover
Navigation and Data Acquisition Software – HYPACK HYSWEEP version 2016A
RTK-GNSS Base Station – Trimble SPS-855, occupying DEA control monument number 2011(adjusted 2010) (North side of Johnny's Dock Restaurant)

Survey Control

For this survey, the existing project survey control monument number 2011 (Table 1) was selected for the RTK-GNSS base station using the adjusted coordinates and elevation derived from the 2010 survey. The selection of monument number 2011 was based on its location for accessibility and good sky access to GNSS signals.

Table 1: GNSS Base Station Number 2011

GPS Base Station Number 2011 (adjusted 2010) 2" Brass Cap stamped: "D.E.A. CONTROL, 2011"					
GRS-80			HORIZONTAL DATUM: SPCS NAD-83/91 WASHINGTON SOUTH ZONE, PROJECT VERTICAL DATUM: Project Datum, UNITS: U.S. FEET		
LATITUDE (D.M.S.)	LONGITUDE (D.M.S.)	ELLIPSOID HEIGHT (Feet)	NORTHING (U.S. Feet)	EASTING (U.S. Feet)	ELEVATION (U.S. Feet)
47°14'46.98881" N	122°25'52.62178" W	-59.997	703520.229	1160785.844	17.256

Field Procedures

Position Check

Each day after base station setup, a confidence check was observed on DEA control monument number 2018, as shown in Table 2, by either decoupling the RTK antenna from the vessel, and placing it on a fixed length staff or using an Trimble R10 GNSS rover. The individual control check deltas are provided in Table 3.

Table 2: Check-in Control Monument Number 2018

Check-in point: DEA Number 2018, 2" Brass Cap No Stamping		
HORIZONTAL DATUM: SPCS NAD-83/91 WASHINGTON SOUTH ZONE, PROJECT VERTICAL DATUM: Project Datum, UNITS: U.S. FEET		
NORTHING (U.S. Feet)	EASTING (U.S. Feet)	ELEVATION (U.S. Feet)
706951.803	1160508.899	16.298

Table 3: Check In Differences

Check-in Observation Differences to Control monument DEA Number 2018				
Method	DATE	Δ EASTING (Feet)	Δ NORTHING (Feet)	Δ ELEVATION (Feet)
Vessel Rover	3/28/2018	0.006	0.038	0.019
R10 Rover	3/28/2018	0.030	0.056	0.012
R10 Rover	3/29/2018	0.038	0.074	-0.033

Patch Test

During survey operations, data were collected along a series of parallel transects to determine the alignment or the Reson 7101 sonar to the POS/MV IMU motion sensor, and system latency. The sonar alignment correction values applied during data processing are shown in Table 4.

Table 4: Correction Values

ROLL	PITCH	YAW	LATENCY
-0.013	-0.413	-0.388	0.00

Sound Speed Casts

Detailed measurements of the speed of sound through the water column are crucial in multibeam surveys. Changes in the sound speed profile will not only affect acoustic distance measurements, but can also cause refraction or bending of the sonar path as it passes through different density layers in the water column. An AML Smart X SVP&T was used to measure the speed of sound through the water column. A total of 32 sound speed casts were collected during survey operations and are displayed in Figure 1.

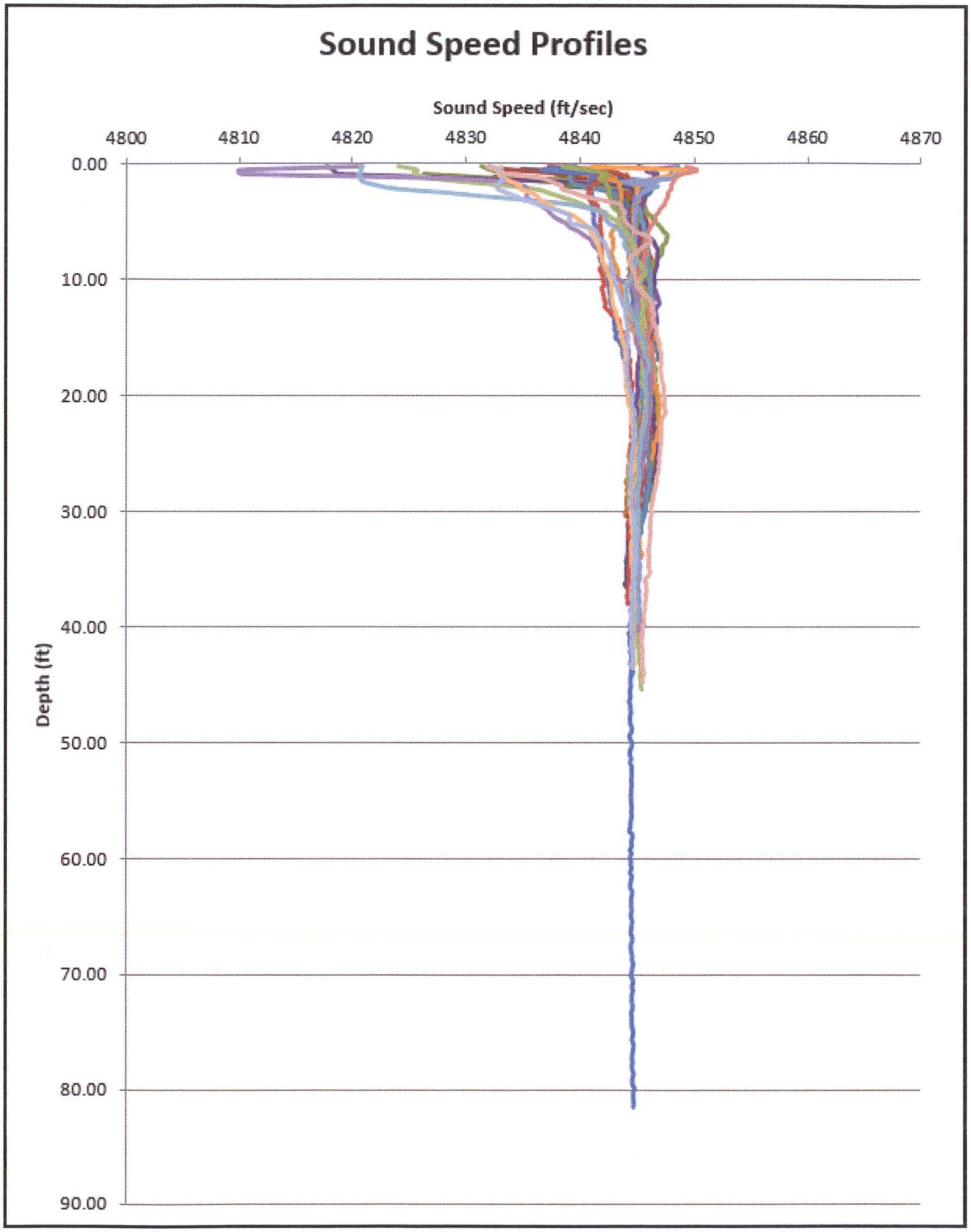

Figure 1: Sound Speed Profiles

Bar Check

A flat aluminum disc, also referred to as a bar, was held below the multibeam sensor to verify draft adjustments to the system. The bar was held at a measured depth of 10 feet directly below the sonar transmit transducer. The data was processed in CARIS Hydrographic Information Processing System (HIPS) software version 10.3.1, and a sample of soundings was averaged. The measured error in the bar check was -0.044 feet.

Bridge Footing Comparison

During the 2010 survey a series of four lead-line soundings were taken on the south side of the eastern bridge footing of the 11th Street Bridge. The images below show the location of the lead-line soundings and a comparison of the 2010 to the 2013 data. Figure 2 is a 3D image indicating the lead line locations during the 2010 survey and yellow box showing the location of the 2D profile as depicted in figure 3. In figure 3, the 2D image is profile of the 2016 and 2018 soundings vertically exaggerated three times, the red soundings represent the 2016 survey data and the yellow soundings represent the 2018 survey data. The two sets of survey data agree within 0.04 feet at the lead-line locations of the 11th Street Bridge footing.

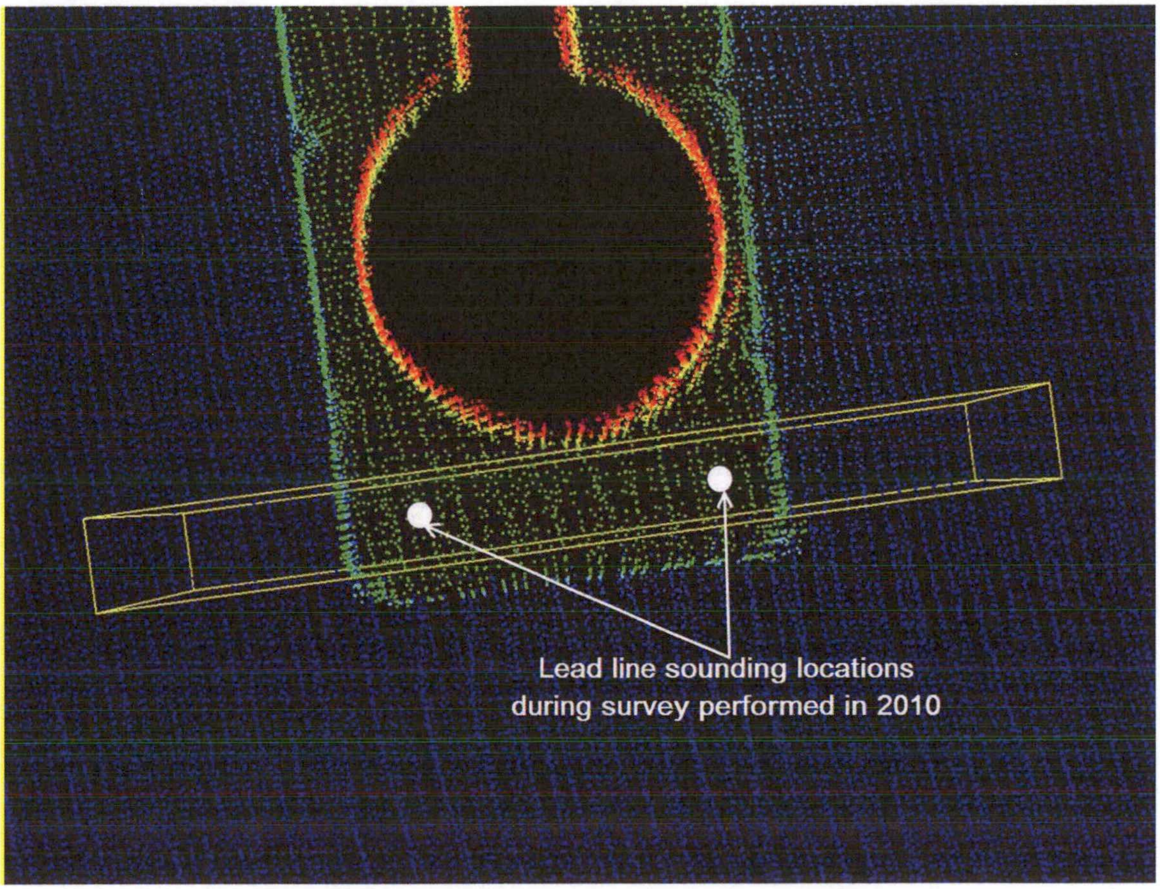

Figure 2: 3D image of 11th Street Bridge footing

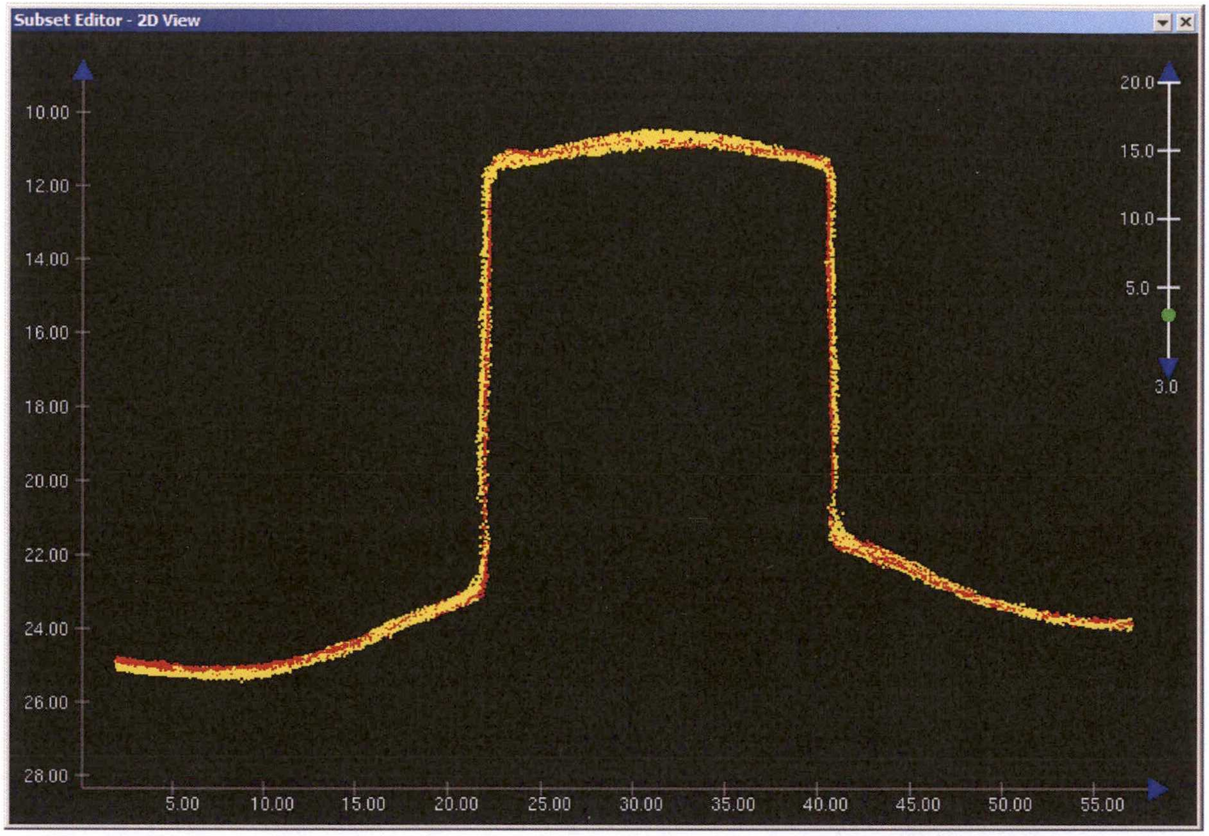

Figure 3: 2D image, Red soundings from 2010 and Yellow soundings is 2018

Multibeam Data Acquisition

Soundings were acquired with a Reson SeaBat 7101 multibeam bathymetric sonar using a frequency of 240 kilo Hertz (kHz). The system records 511 soundings in a single sonar ping.

Multibeam data acquisition was conducted by running lines both parallel and perpendicular with the waterway for the length of the project. Very few areas were inaccessible or blocked by large vessels. The birth at Site 14, Martinec, contained a large fishing vessel undergoing repairs. The presence of the vessel limited the upslope multibeam coverage. Sonar swaths were recorded at a rate up to 20 Hz as the vessel transited along the survey track lines. Multibeam data were clipped at 45° (90° total swath width) during processing to improve data quality for the main waterway. The accepted angles were opened up along the slopes to reach under obstructions. The total swath width of full coverage mapping in a single pass varied with the water depth.

The most vital measurements in a multibeam survey are heading and roll angles. To account for vessel heading, heave (vertical movement), pitch and roll, an Applanix POS/MV positioning and motion reference sensor was utilized. By utilizing vessel speed over ground and heading data provided by GNSS, the POS/MV can isolate horizontal accelerations from vessel turns and provide highly accurate motion data. The POS/MV system also recorded vessel heading (yaw), which was used to determine sonar beam orientation. The POS/MV provides a higher degree of accuracy for heading measurements than a conventional gyrocompass.

The navigation and survey control system was a personal computer running Hypack 2016A software. Hypack Hysweep software was used for multibeam and sensor data acquisition. Hypack software allowed the swath bathymetric data to be displayed as a color image in a "matrix" on the navigation screen. The matrix cell size was set to 1.60 feet during operations and nearly all cells were filled with sounding data. This real-time display gave the hydrographer immediate indications of data quality and coverage.

Processing Procedures

Tides

The elevation data obtained from the RTK-GNSS system was written to the Hypack Raw files. Using Hypack single-beam editor software, the RTK tide data was smoothed, edited, and corrected to Project Datum using a single value of -23.55 meters (-77.25 feet), which adjusts the GPS GRS80 ellipsoidal heights to project vertical datum. The data were then reviewed for spikes or outages.

In addition, tide data from the NOAA gauge in Tacoma (9446484), based on Mean Lower Low Water (MLLW) was downloaded for a portion of the survey period for comparison. These 6-minute NOAA MLLW values were adjusted to Project Datum by adding 0.80 feet. A graph showing the comparison of the two tide datasets showed close agreement in relative water level changes during the survey as demonstrated in Figure 4. The RTK tide was used for reducing all soundings to elevations relative to Project Datum.

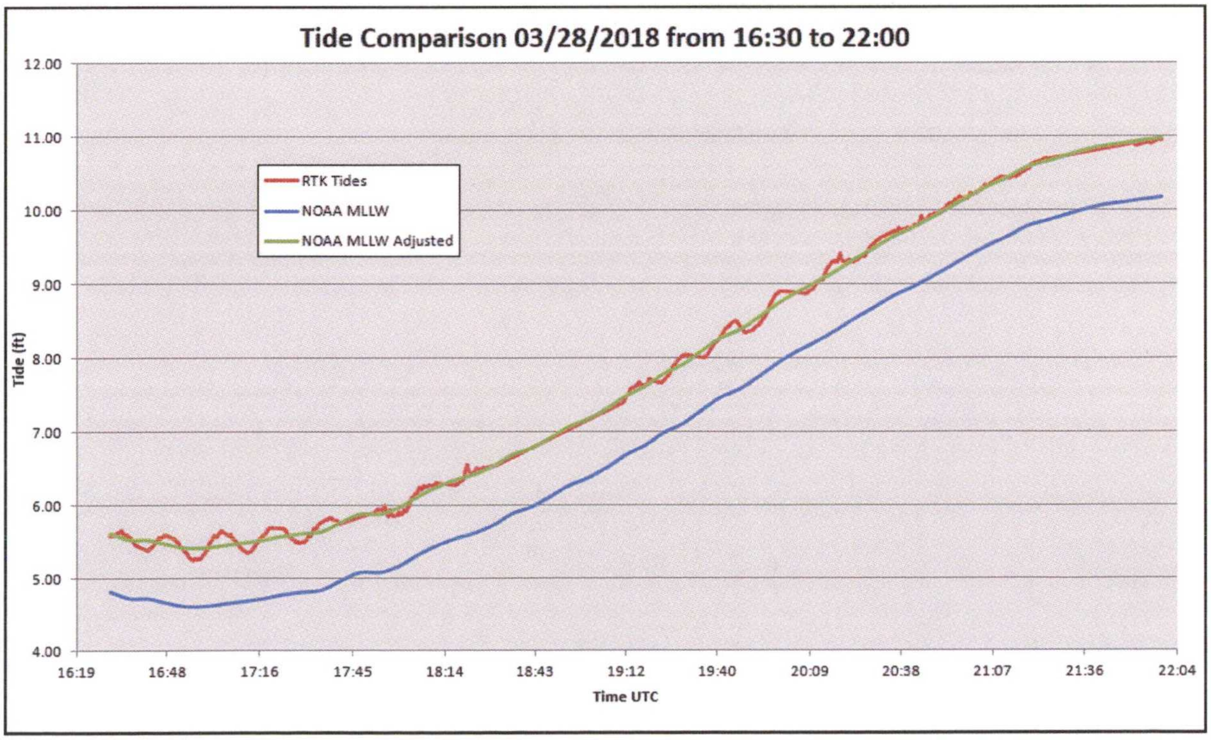

Figure 4: Tide Comparison

Data Editing

Processing of the multibeam data was conducted utilizing CARIS software. Patch test data were analyzed and alignment corrections were applied. Water-level data were applied to adjust all depth measurements to Project Datum from the RTK-GNSS processed water level data. Sound speed profiles were used to correct slant range measurements and compensate for any ray path bending. Position and sensor data were reviewed and accepted. Sounding data were reviewed and edited for data flyers. Sounding data, including sonar beams reflecting from sediment in the water column or noise in the water column, were carefully reviewed before flagged as rejected. In each case, data was not eliminated and can be re-accepted in the future if required.

Data Export

To take advantage of the level of detail the multibeam bathymetric survey provided for the waterway, a 0.5-meter (1.6 feet) grid of the survey area was created in CARIS software and exported to an ASCII XYZ file. This process created a 0.5-meter (1.6 feet) elevation grid over the survey coverage area then assigned elevation values to each grid node using an inverse distance weighted algorithm. The ASCII XYZ points file uses the North American Datum of 1983-91 (NAD83-91), State Plane Coordinate System (SPCS), Washington South Zone with units in U.S. Survey feet.

Data Images

The 0.5-meter (1.6 feet) gridded data was rendered in CARIS software to produce a hillshade image of the bathymetry. The hillshade image is a colored rendering of the surface with shadows created by an artificial sun to help draw out features and make the image more interpretable. For the Thea Foss Waterway, a 5x5 interpolation was applied to the 0.5-meter (1.6 feet) gridded surface to reduce the distracting effects of empty pixels. The interpolation was only applied to the hillshade image and not to any other products. The parameters used for creating the hillshade are shown in Table 5.

Table 5: Hillshade Parameters

Sun Azimuth	Sun Elevation	Vertical Exaggeration	Color	Color Range (Feet)
315°	45°	2x	Earth	-10 to 50

Multibeam data from a post construction survey of the Thea Foss Waterway (baseline) and Year-10 monitoring survey, conducted by DEA in 2006, and 2016 respectively, were imported into CARIS software and difference values calculated by subtracting each of these surfaces from the current Year-12 (2018) surface model. A difference image was produced to show where bottom changes had occurred at a one half-foot interval. The image is predominantly gray, indicating that the bottom changed less than +/- one half-foot. Green colors indicate areas where the bottom is shallower than previous, and blue colors indicate areas where the bottom is now deeper. A new hillshade image of the Year-12 (2018) data was produced using the same color and illumination parameters as prior deliverables, so all surveys could be directly compared.

Profiles

The Year-12 (2018) processing included the production of 17 profiles to compare bottom conditions to the previous surveys. Profiles were generated along the same 17 profile sections used in prior surveys and displayed with the previous cross-section data for evaluation of time series change along the profile. The profiles were generated in Terramodel version 10.61 software and exported to a AutoCAD DXF file. The AutoCAD DXF file was provided with the profiles from Year-12 (2018) and the previous years along with the station/elevation values in a table format. The DXF file also included the profile alignments, the provided 2018 survey limits and remedial area boundaries. The DXF file is intended for graphical information and data to be used to generate final profile presentation drawings by Floyd-Snider.

Data Contours

The exported soundings from the March 2018 multibeam survey were imported into Trimble Terramodel version 10.61 software for quality control checks and generation of the initial DTM for each area. The DTM elements and points were exported to an AutoCAD DXF file to be used in AutoCAD Civil 3D 2014 to generate the final mapping of the 0.5-foot elevation contours.\

A hardcopy set of the contour mapping, stamped and signed by a licensed Washington Professional Land Surveyor (PLS) and signed by a National Society of Professional Surveyors -The Hydrographic Society of America (NSPS-THSOA) Hydrographer was also produced.

Vessel Track Lines

The survey vessel track lines were exported from Hypack as an AutoCAD DXF file using only the accepted survey lines used in the final model.

ASCII Point Files

ASCII Point files were exported individually of each area, as well as a file containing all data points combined. The format of the ASCI points files is Easting, Northing, Elevation, Description using comma delimitated format, delivered along with this memorandum.

This memorandum was prepared and reviewed for the City of Tacoma by:

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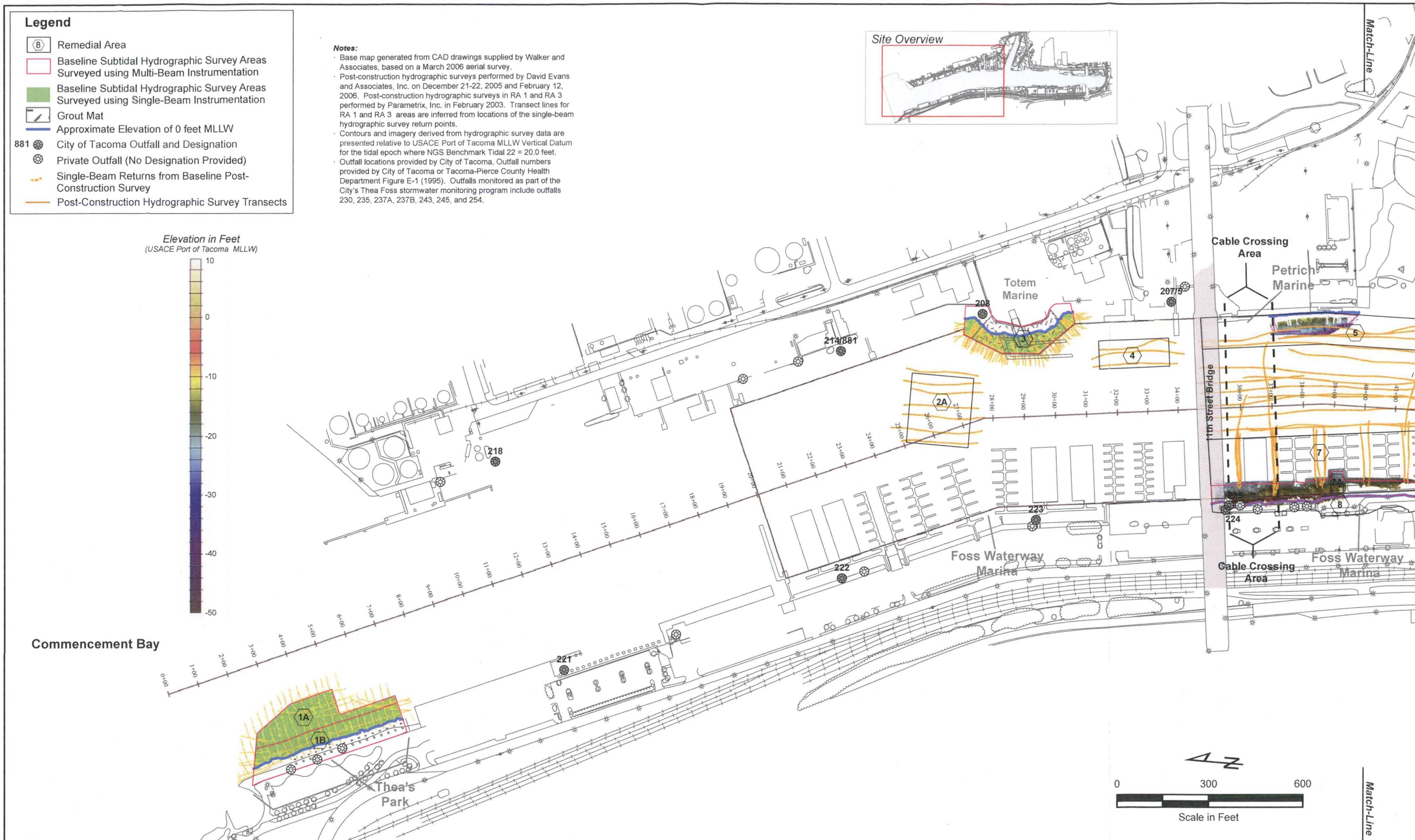
ATTACHMENT B

BASELINE, YEAR 2, YEAR 10, AND YEAR 12 SURVEY TRANSECT LINES



Notes:

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic surveys performed by David Evans and Associates, Inc. on December 21-22, 2005 and February 12, 2006. Post-construction hydrographic surveys in RA 1 and RA 3 performed by Parametrix, Inc. in February 2003. Transect lines for RA 1 and RA 3 areas are inferred from locations of the single-beam hydrographic survey return points.
- Contours and imagery derived from hydrographic survey data are presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995). Outfalls monitored as part of the City's Thea Foss stormwater monitoring program include outfalls 230, 235, 237A, 237B, 243, 245, and 254.

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Figure B.1 (Page 1 of 2)
Overview of Baseline Hydrographic Survey Transect Lines

File: F:\projects\COT-Oncall\GIS\2008 Hydrographic PFM\MXD\Report Figures\Figure C.1 (Overview of Baseline Hydrographic Survey Areas with Transect Lines (1of2)).mxd
5/23/2008 10:05 AM

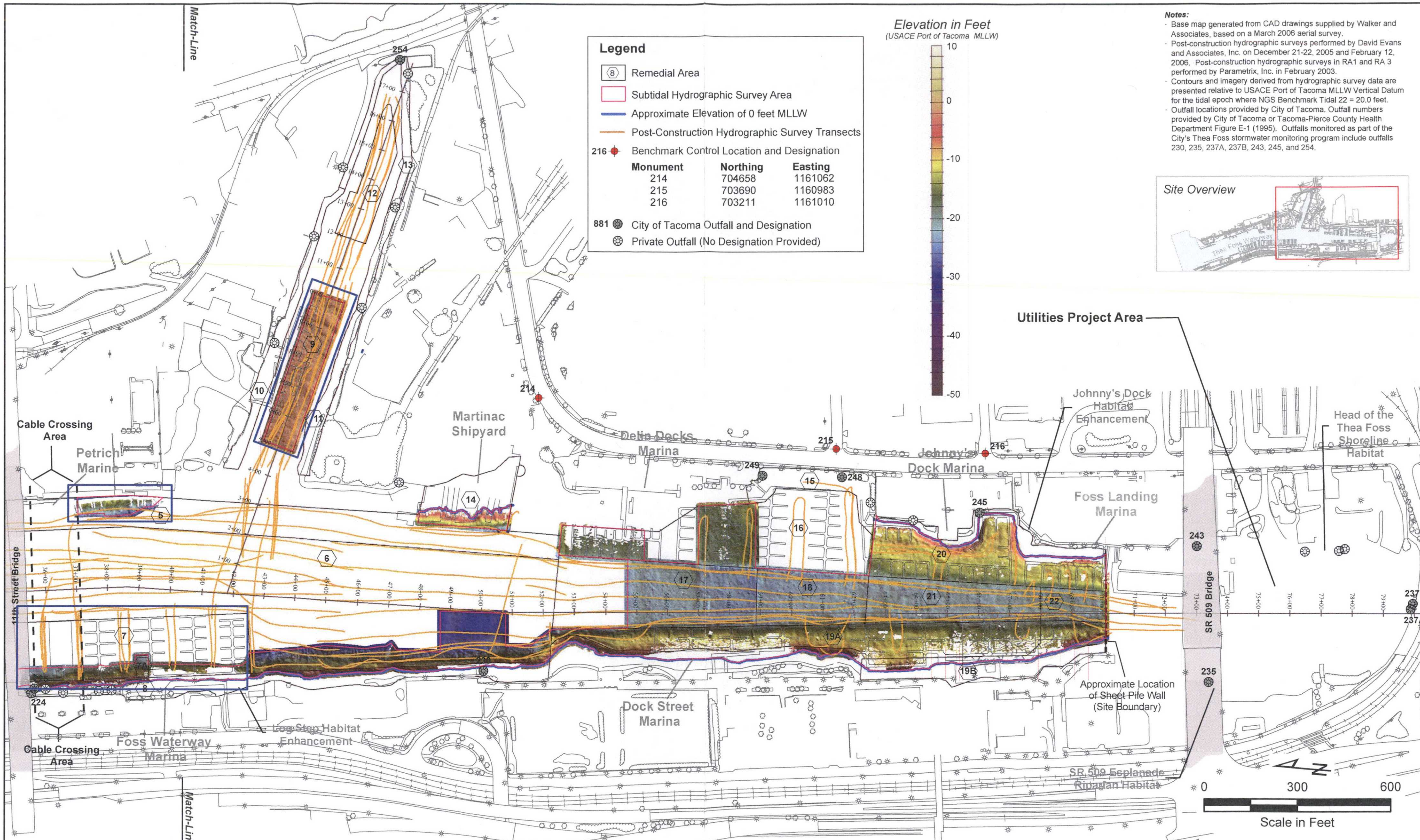

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Figure B.1 (Page 2 of 2)
Overview of Baseline Hydrographic Survey Transect Lines

File: F:\projects\COT-Oncall\GIS\2008 Hydrographic PFM\MXD\Report Figures\Figure C.1 (Overview of Baseline Hydrographic Survey Areas with Transect Lines (2of2)).mxd
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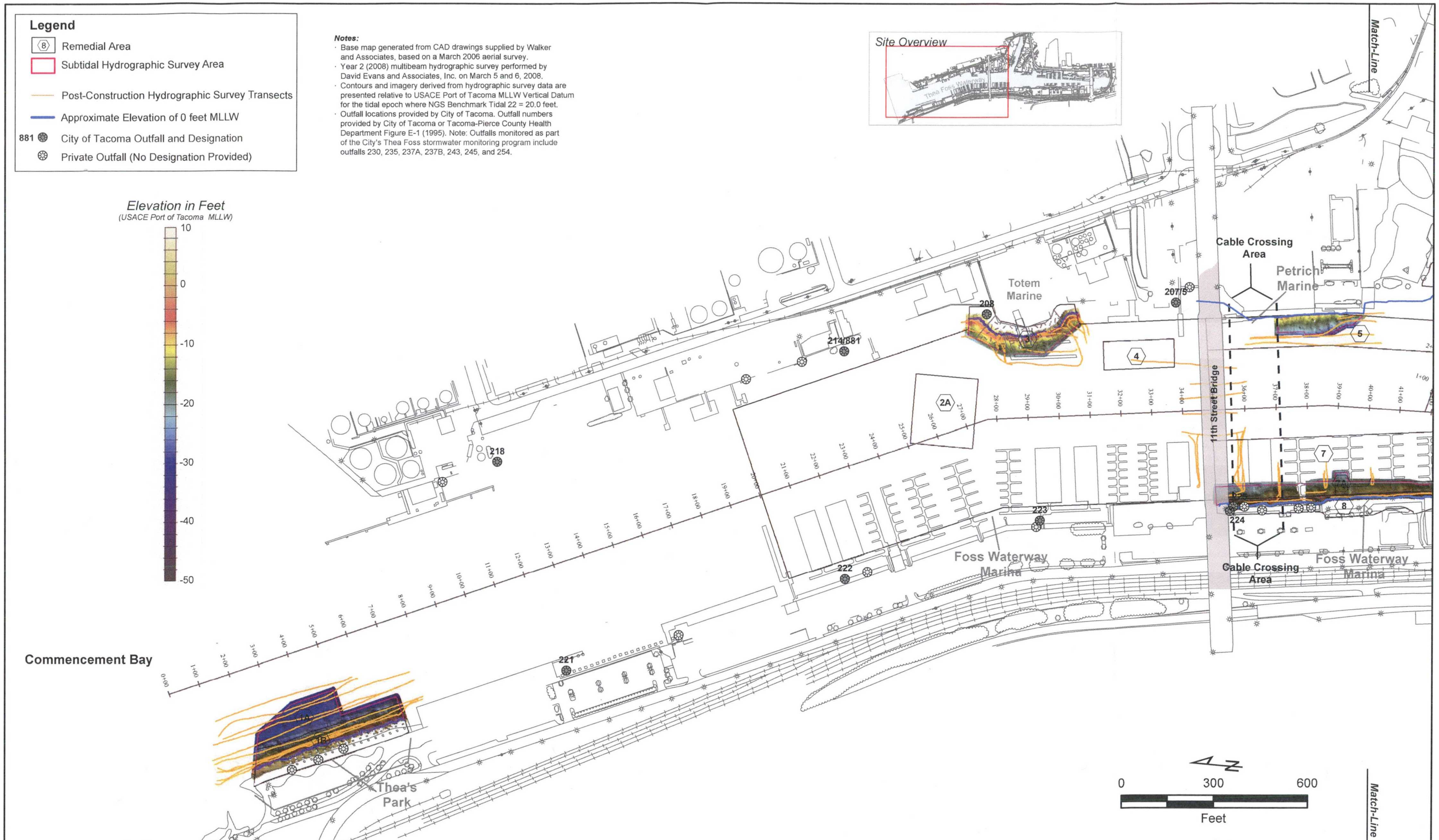

Notes:

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Year 2 (2008) multibeam hydrographic survey performed by David Evans and Associates, Inc. on March 5 and 6, 2008.
- Contours and imagery derived from hydrographic survey data are presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995). Note: Outfalls monitored as part of the City's Thea Foss stormwater monitoring program include outfalls 230, 235, 237A, 237B, 243, 245, and 254.

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**Figure B-2 (Page 1 of 2)
Overview of Year 2 (2008)
Hydrographic Survey Transect Lines**

File: F:\projects\COT-Oncall\GIS\2008 Hydrographic PFM\MXD\Report Figures\Figure C.2 (Overview of Year 2 (2008) Hydrographic Survey Areas with Transect Lines (1of2)).mxd
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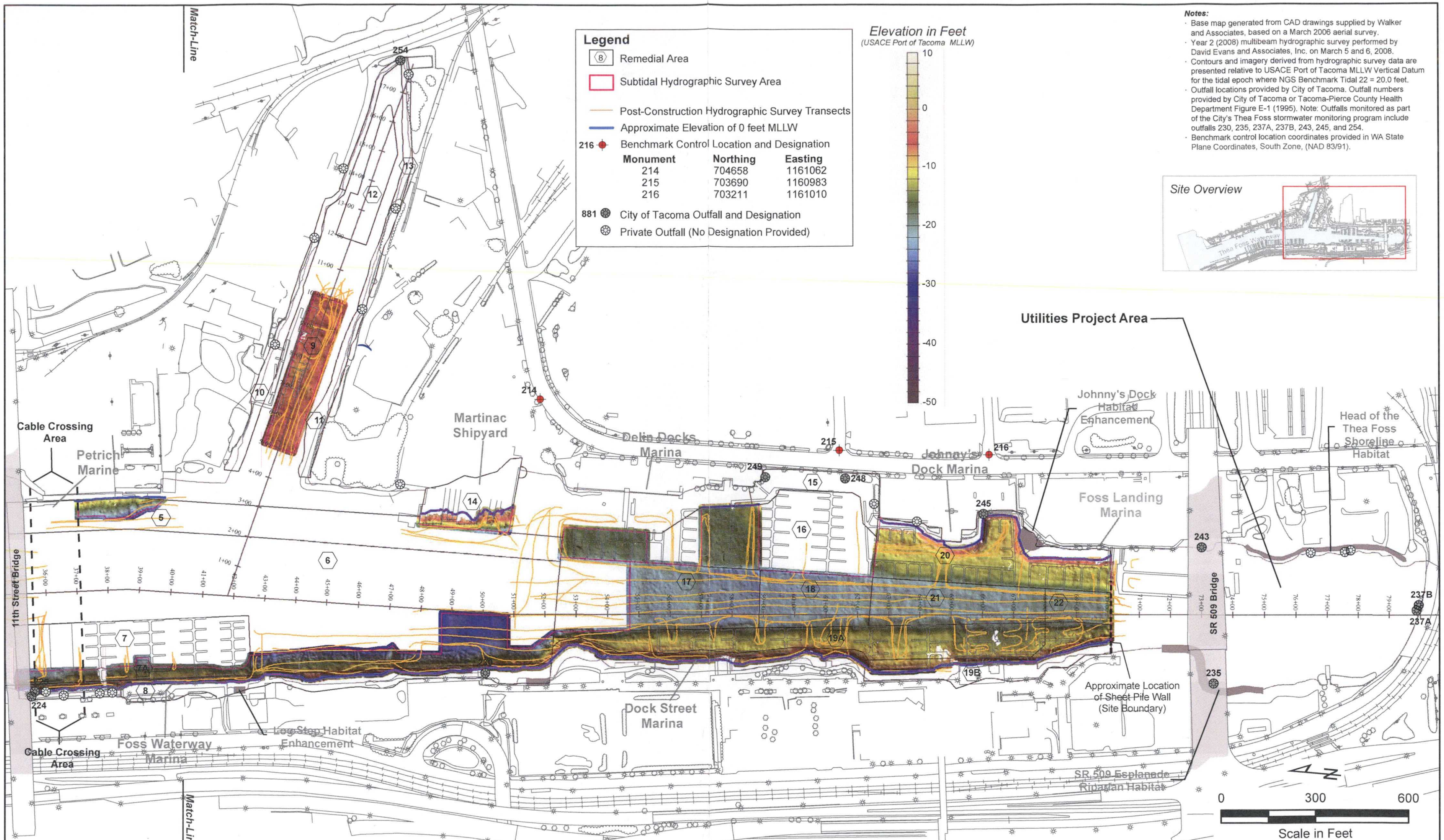

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Figure B-2 (Page 2 of 2)
Overview of Year 2 (2008) Hydrographic Survey Transects

File: F:\projects\COT-Oncall\GIS\2008 Hydrographic PFM\MXD\Report Figures\Figure C.2 (Overview of Year 2 (2008) Hydrographic Survey Areas with Transect Lines (2of2)).mxd
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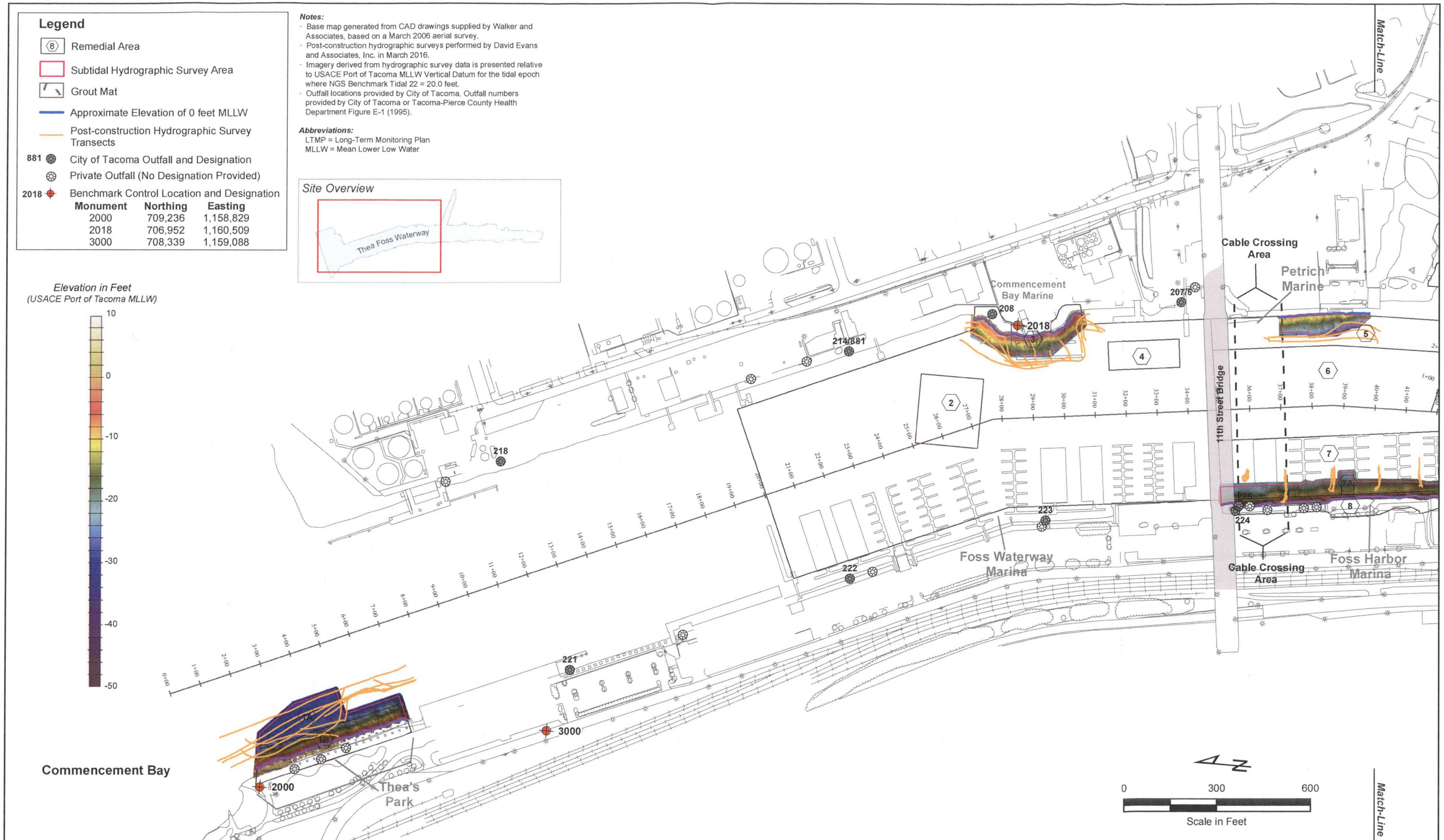

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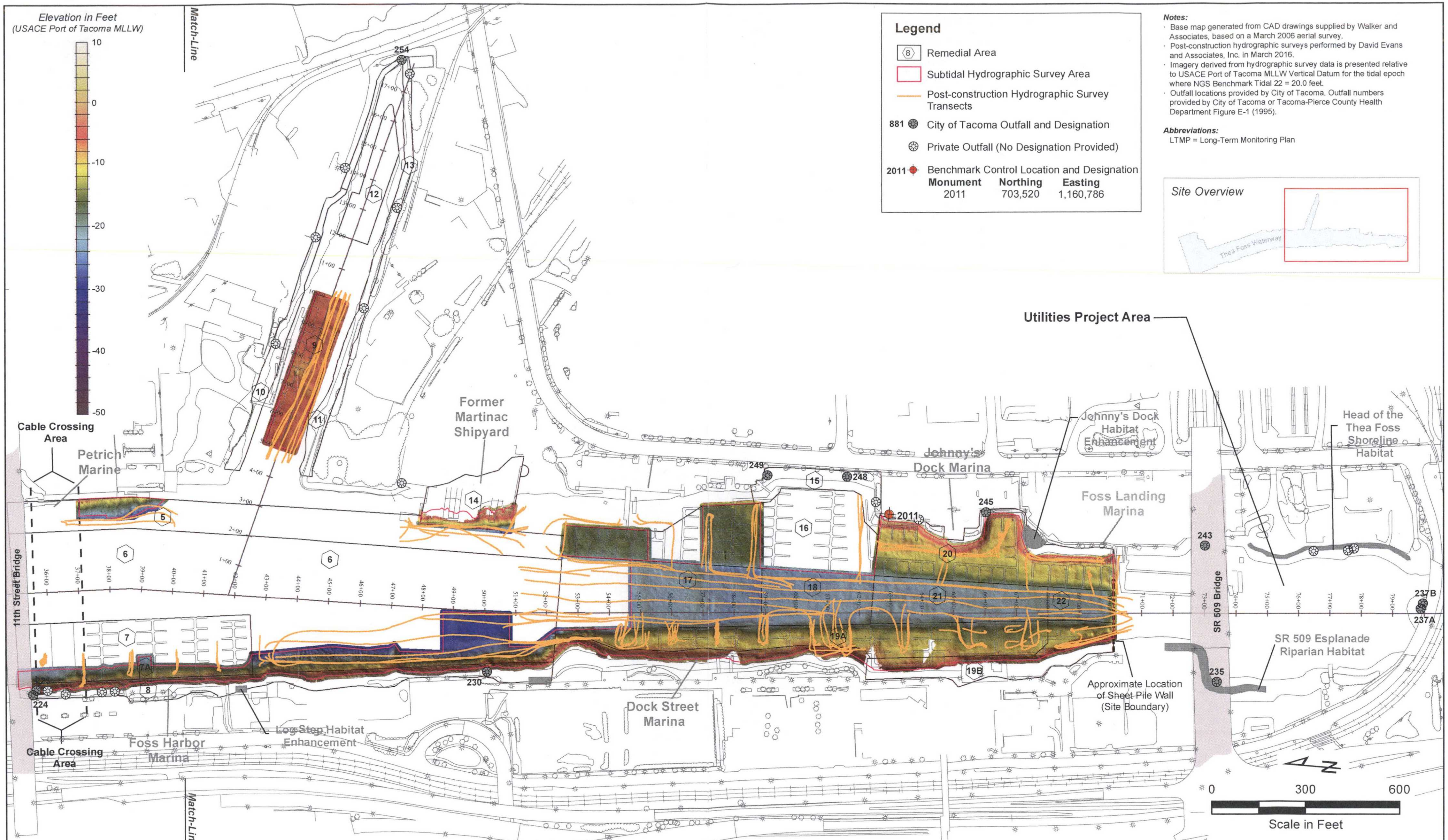
Figure B-3 (Page 1 of 2)
Overview of Year 10 (2016)
Hydrographic Survey Transect Lines

I:\GIS\Projects\COT_ON_CALL\MXD\2018 Yr 12 Hydrographic Survey PFM\Figure B-3 (Overview of Year 10 (2016) Hydrographic Survey Areas with Transect Lines (1of2)).mxd
7/30/2018



Legend

- Remedial Area
- Subtidal Hydrographic Survey Area
- Post-construction Hydrographic Survey Transects
- 881 City of Tacoma Outfall and Designation
- Private Outfall (No Designation Provided)
- 2011 Benchmark Control Location and Designation

Monument	Northing	Easting
2011	703,520	1,160,786

Notes:

- Base map generated from CAD drawings supplied by Walker and Associates, based on a March 2006 aerial survey.
- Post-construction hydrographic surveys performed by David Evans and Associates, Inc. in March 2016.
- Imagery derived from hydrographic survey data is presented relative to USACE Port of Tacoma MLLW Vertical Datum for the tidal epoch where NGS Benchmark Tidal 22 = 20.0 feet.
- Outfall locations provided by City of Tacoma. Outfall numbers provided by City of Tacoma or Tacoma-Pierce County Health Department Figure E-1 (1995).

Abbreviations:

LTMP = Long-Term Monitoring Plan

Site Overview

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Figure B-3 (Page 2 of 2)
Overview of Year 10 (2016)
Hydrographic Survey Transect Lines

I:\GIS\Projects\COT_ON_CALL\MXD\2018 Yr 12 Hydrographic Survey PFM\Figure B-3 (Overview of Year 10 (2016) Hydrographic Survey Areas with Transect Lines (2of2)).mxd
7/30/2018

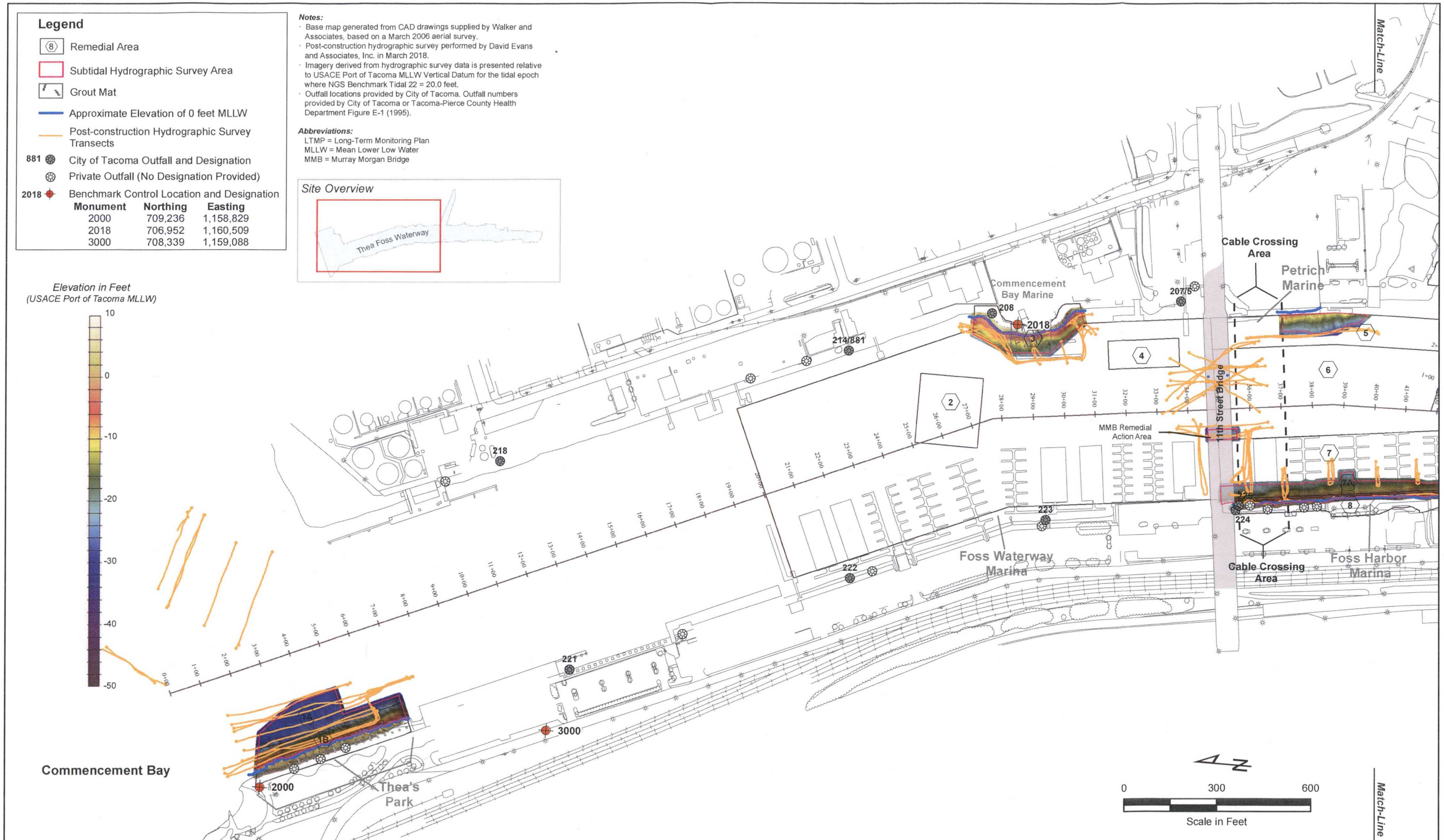

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Figure B-4 (Page 1 of 2)
Overview of Year 12 (2018)
Hydrographic Survey Transect Lines

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I:\GIS\Projects\COT_ON_CALL\MXD\2018 Yr 12 Hydrographic Survey PFM\Figure B-4 (Overview of Year 12 (2018) Hydrographic Survey Areas with Transect Lines (1of2)).mxd
7/30/2018

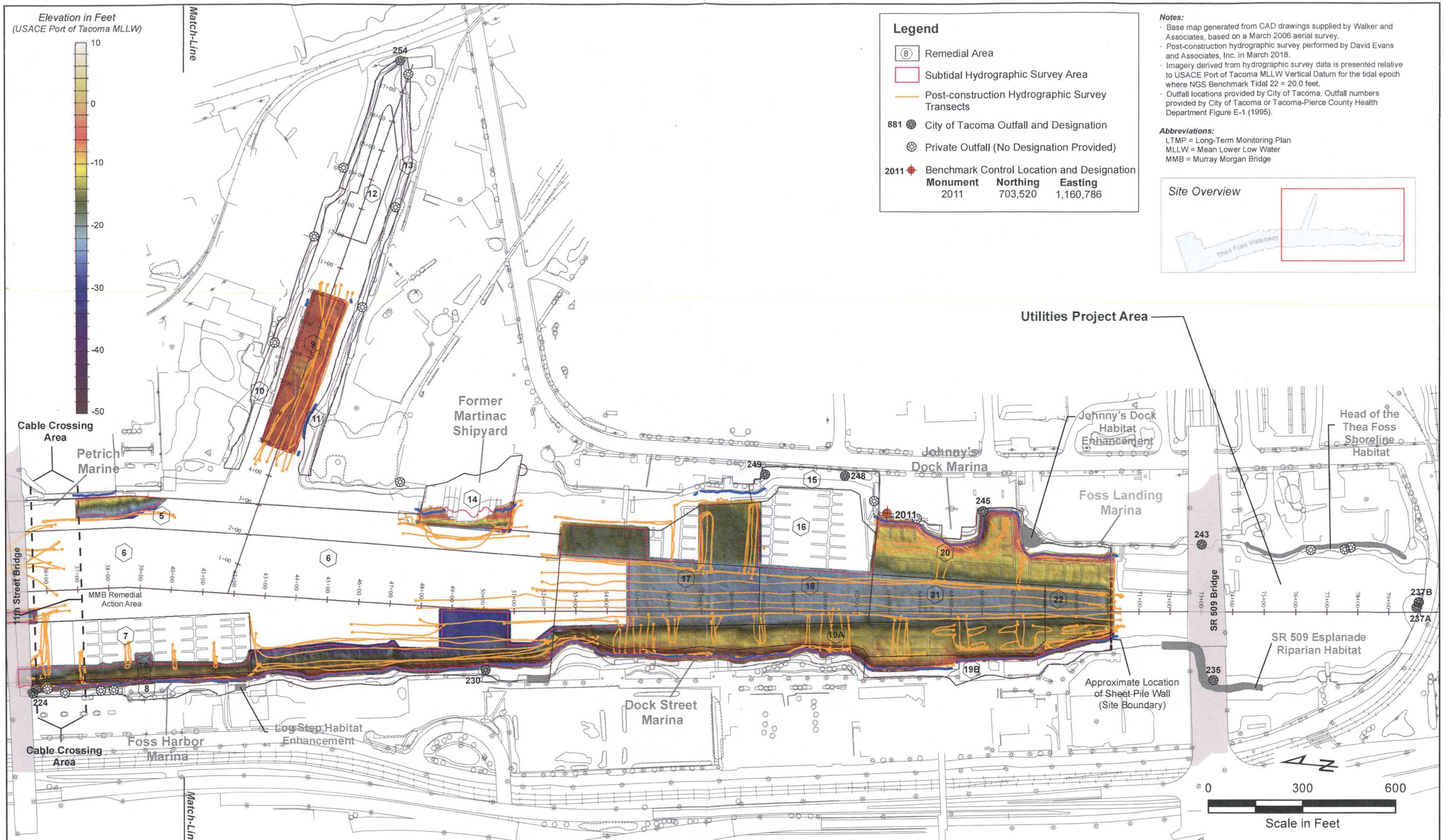

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Figure B-4 (Page 2 of 2)
Overview of Year 12 (2018)
Hydrographic Survey Transect Lines

I:\GIS\Projects\COT_ON_CALL\MXD\2018 Yr 12 Hydrographic Survey PFM\Figure B-4 (Overview of Year 12 (2018) Hydrographic Survey Areas with Transect Lines (2of2)).mxd
7/30/2018

ATTACHMENT C

PHOTOGRAPHS

Photograph 1. View of Vessel Moored in Front of Remedial Area 14
(Facing North/Northeast in Thea Foss Waterway)

Photograph 2. View of Vessel Moored in Front of Remedial Area 14
(Facing South/Southeast in Thea Foss Waterway)